



# 5-YEAR

## Information Technology Strategic Plan

Version 1.0

06/22/09

**Ted Brodheim**

Chief Information Officer

**Steve Vigilante**

Deputy Chief Information Officer  
Infrastructure

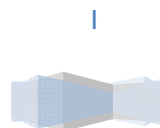
**Alejandro Mainetto**

Deputy Chief Information Officer  
Applications Development

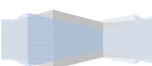


# TABLE OF CONTENTS

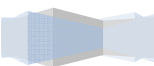
SECTION 1: EXECUTIVE SUMMARY .....	1
CONTENTS SUMMARY.....	2
SECTION 2: VISION AND GOALS .....	4
INTRODUCTION.....	4
TRENDS IN EDUCATION AND TECHNOLOGY .....	5
WEB 3.0 (SEMANTIC WEB) AND INTERNET TRENDS .....	8
DESIGN STANDARDS AND METHODOLOGY .....	9
SECTION 3: GUIDING PRINCIPLES.....	11
CHILDREN FIRST INTENSIVE .....	11
<i>Children First Today</i> .....	11
CHILDREN FIRST INTENSIVE .....	12
PROFESSIONAL DEVELOPMENT .....	14
TEACHING AND LEARNING .....	17
<i>Office of eLearning</i> .....	17
<i>Teaching and Learning</i> .....	18
<i>NYC21C Initiative</i> .....	21
SPECIAL EDUCATION.....	26
SECTION 4: SCHOOL INFRASTRUCTURE .....	30
VISION.....	30
GOAL AND STRATEGY TO OBTAIN VISION .....	30
CURRENT STATE .....	31
TARGET STATE .....	31
RECOMMENDATIONS AND ROADMAP .....	32
BENEFITS AND IMPACT IF NOT IMPLEMENTED .....	35
BUDGET TO IMPLEMENT.....	36
SECTION 5: DATA CENTER SERVICES .....	37
VISION.....	37
UNIFIED STORAGE AND ENTERPRISE SERVERS.....	37
GOAL AND STRATEGY TO OBTAIN VISION .....	37
CURRENT STATE .....	38
CURRENT CHALLENGES .....	38
TARGET STATE .....	39
RECOMMENDATIONS AND ROADMAP .....	42
BENEFITS AND IMPACT IF NOT IMPLEMENTED .....	44
BUDGET TO IMPLEMENT.....	44
SECTION 6: NETWORK INFRASTRUCTURE .....	45
CONVERGED NETWORK INFRASTRUCTURE .....	45
VISION.....	45
GOALS AND STRATEGY TO OBTAIN VISION .....	45
CURRENT STATE .....	46
FUTURE STATE .....	47
RECOMMENDATIONS AND ROADMAP .....	48
BENEFITS AND IMPACT.....	49



BUDGET TO IMPLEMENT .....	50
NEXT GENERATION WIRELESS NETWORK .....	51
VISION.....	51
GOALS AND STRATEGY TO OBTAIN VISION .....	51
CURRENT STATE .....	53
TARGET STATE (FUTURE STATE) .....	55
RECOMMENDATIONS AND ROADMAP .....	58
PROFESSIONAL DEVELOPMENT (INCLUDING PEDAGOGICAL AND .....	59
BENEFITS AND IMPACT IF NOT IMPLEMENTED .....	60
BUDGET TO IMPLEMENT.....	61
<b>SECTION 7: PC LIFECYCLE MANAGEMENT AND END-USER COMPUTING.....</b>	<b>62</b>
VISION.....	62
GOALS AND OBJECTIVES TO OBTAIN VISION .....	65
CURRENT STATE .....	67
FUTURE STATE .....	67
RECOMMENDATIONS AND ROADMAP .....	70
BENEFITS AND IMPACT IF NOT IMPLEMENTED .....	70
BUDGET TO IMPLEMENT.....	71
<b>SECTION 8: INFORMATION SECURITY AND IDENTITY .....</b>	<b>72</b>
VISION.....	72
GOAL AND STRATEGY TO OBTAIN VISION .....	72
CURRENT STATE .....	72
TARGET STATE (FUTURE STATE) .....	73
RECOMMENDATIONS AND ROADMAP .....	74
BENEFITS AND IMPACT IF NOT IMPLEMENTED .....	84
BUDGET TO IMPLEMENT.....	84
<b>SECTION 9: STUDENT/TEACHER LEARNING AND COLLABORATION .....</b>	<b>85</b>
VISION.....	85
GOAL AND STRATEGY TO OBTAIN VISION .....	85
CURRENT STATE .....	86
FUTURE STATE .....	87
RECOMMENDATIONS AND ROADMAP .....	87
BENEFITS AND IMPACT.....	89
BUDGET TO IMPLEMENT.....	89
<b>SECTION 10: USER SUPPORT (NOC AND SERVICE CENTER) .....</b>	<b>90</b>
THE NETWORK OPERATIONS CENTER (NOC) .....	90
VISION.....	90
GOAL AND STRATEGY TO OBTAIN VISION .....	90
CURRENT STATE .....	91
TARGET STATE (FUTURE STATE) .....	92
RECOMMENDATIONS AND ROADMAP .....	93
BENEFITS AND IMPACT IF NOT IMPLEMENTED .....	93
BUDGET TO IMPLEMENT.....	93
HELP DESK (SERVICE CENTER).....	94
VISION.....	94
CURRENT STATE .....	94
RECOMMENDATIONS AND ROADMAP .....	95
BENEFITS AND IMPACT.....	96

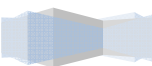


BUDGET TO IMPLEMENT.....	96
<b>SECTION 11: EVALUATION AND ASSESSING NEW TECHNOLOGY .....</b>	<b>97</b>
VISION.....	97
GOAL AND STRATEGY TO OBTAIN VISION .....	98
CURRENT STATE .....	98
TARGET STATE .....	98
RECOMMENDATIONS AND ROADMAP .....	98
BENEFITS AND IMPACT IF NOT IMPLEMENTED .....	99
BUDGET TO IMPLEMENT.....	99
<b>SECTION 12: OVERALL BUDGET PLAN .....</b>	<b>100</b>
BUDGET TO IMPLEMENT.....	100



## SECTION 1: EXECUTIVE SUMMARY

The New York City Department of Education’s (NYCDOE) IT Strategic Planning process incorporates regular examination of the plans and priorities for the use and support of information technology to deliver instructional and administrative services. Throughout the process, we examine our currently installed solutions with a view to aligning them with technology and educational industry trends. This document describes the current state of the NYCDOE technology infrastructure, while outlining a robust and innovative vision designed to meet the instructional needs of our students over the next three-to-five years. The ultimate goal is to build an evolutionary roadmap of cost-justifiable projects to support the NYCDOE in its efforts to strengthen and enhance its core application and hardware infrastructure to provide quality services to enhance all aspects of teaching and learning—while enabling schools to tailor their environments to meet specific goals and objectives.



## *Contents Summary*

Following the Executive Summary (Section 1), this document includes eleven additional sections.

Section 2, Vision and Goals, describes the trends that underlie the technology proposals found in this Strategic Plan. The main trends evident in this section are a commitment to individualized approaches to education, the provision of access to NYCDOE network resources anywhere and anytime, rather than having this access restricted to the classroom, and the introduction of technology that allows collaboration among students, educators and administrators.

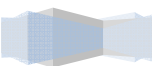
Section 3, Guiding Principles, focuses on the guiding principles of the educational transformation represented by the five-year plan. First, the Children First initiative, conceived jointly by Mayor Bloomberg and Chancellor Klein, is discussed. Then, the changes in curriculum and instructional technology, and advances in teaching and learning methodologies that the plan encourages and supports, are delineated.

Section 3 also highlights the role of professional development in ongoing technology deployment. As new technology is deployed, teachers and staff must be adequately instructed in its use and guided in best practices in order for the technology to have a significant impact on student performance. This section describes DIIT's approach to this goal.

As part of the evolving relationship between DIIT and the schools, DIIT is developing a menu of technology options for schools. Section 4, School Infrastructure, includes future directions in desktop/mobile services and support structure. It also describes key changes in technology implementation over the next five years. This section describes options such as school-based instructional applications servers, various approaches to computer hardware (thin-client, laptops, hand-held devices, etc.), options for video conferencing (e.g., video conferencing rooms with large fixed screens vs. portable video conferencing equipment that can be moved room-to-room) and others.

Many of the applications used by staff throughout the DOE depend on the resources of the Data Center at 2 Metrotech Center. This complex housing a large collection of servers and other special purpose computers, and new approaches to technology will have a significant impact on how the Data Center provides these services efficiently. Section 5, Data Center Infrastructure, describes ongoing plans for the Data Center, and the cost savings that can be realized through its implementation. To overcome the continuous increase in the server base, DIIT has decided to create a virtual environment for less utilized/non-critical servers, and break away from hardware dependency for running an operating environment.

Section 6, Network Infrastructure, describes two significant network technology trends, and DIIT's plans to implement these. The first is the concept of a converged network, in which voice and data are handled in similar ways. This represents a significant change from current operations, and required new networks and hardware for implementation. The second is the growing trend in mobile computing, describing new directions in wireless technology.



Section 7, PC Lifecycle Management & End-User Computing, focuses on various efforts to enhance the instructional environment using computers. By implementing technologies such as centralized storage and virtual desktops, computer networks will support collaborative learning to an unprecedented extent, and expand computer use far beyond the boundaries of the classroom.

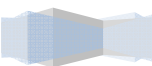
Section 8, Information Security and Identity, describes efforts to ensure that everyone can access the information needed, but to limit access to only those who should have it. These seemingly contradictory goals – simplifying access when appropriate while restricting access when inappropriate – require new approaches in an environment that emphasizes mobility and ubiquitous access.

Section 9, Student Learning and Collaboration, discusses a trend in education that is expected to accelerate over the coming years, and complements the educational trend away from teacher-centric environments. This section describes efforts to facilitate collaborative techniques using new technology.

The health of the entire DOE network is currently monitored from a single location, the Network Operations Center at 2 MTC. Over the course of the next five years, the NOC will undergo significant changes, described in Section 10, User Support (NOC and Service Center). This section describes planned enhancements to Network Management software that will both enhance NOC functionality and distribute that functionality more widely, allowing school staff to monitor the health of local operations.

Section 11 discusses DIIT plans for assessing new technology. Assessment of new technology prior to introduction follows a formal process that includes evaluation and extensive testing. What is new in this strategic plan is a proposed process that involves user assessment of technology after it is introduced into the field.

Budget information is provided in many of the sections of this Strategic Plan, describing the budgets required to implement each of the new technologies. These budget estimates are synthesized in Section 12, the Overall Budget Plan.



## SECTION 2: VISION AND GOALS

### *Introduction*

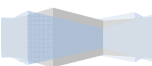
In recent years, the New York City Department of Education (NYCDOE) has made great strides in assessing its educational and operational effectiveness. Through this process of self-examination and improvement, technologies have been adapted and enhanced to provide an infrastructure for students, teachers and administrators, which providing additional services, while improving operational efficiency.

Technology continues to change at a rapid pace, and today's NYCDOE network is much different from the network that existed just a few years ago. As examples, within the last five years the NYCDOE has implemented a high speed optical SONET ring network to support communications between schools and the NYCDOE's data center at 2 MetroTech and its mainframe at 11 MetroTech; it has provided fiber WAN connections to hundreds of schools to enable much faster Internet service; it has delivered an infrastructure that supported the consolidation and creation of the Regional Operational Centers (ROCs) and supports the Integrated Service Centers (ISCs) that have taken their place; and it has deployed a state-of-the-art Network Operations Center at 2 MetroTech Center to monitor network status throughout the NYCDOE.

We see a trend toward usage of a wider range of technology devices in schools. Five years ago, students primarily used wired, desktop computers to access the Internet and other educational resources. Now, students and teachers are going online with many different mobile devices, including laptops, tablets, handheld devices, and eBook readers. We expect this trend to continue and accelerate. One of the NYCDOE's goals is to ensure that the range of devices work well within the enterprise network architecture.

Key to the successful implementation of the plan outlined in this document relies on defining our goals in educational, rather than technological terms. There is an intense focus on transforming the traditional, teacher-led instructional paradigm to a 21<sup>st</sup> Century model which places focus on student-centered differentiated paradigm. Technology is seen as an integral tool in realizing this transformation. Therefore, this plan must enable customization and flexibility since options for technology will continue to change within the five year scope. The 5-Year Strategic Technology Plan focuses on four key areas to support this transformation:

- ⊕ Support for strategic initiatives in Teaching and Learning, Assessment and Accountability, and Special Education.
- ⊕ Enterprise eLearning environment for students and staff including the design and implementation of a comprehensive learning and content management platform.
- ⊕ A range of technology services allowing for individualization to meet school-specific goals and objectives.
- ⊕ Access to NYCDOE network resources from anywhere, anytime, using any device.





These areas will increasingly rely on the DOE's ability to enhance and support the following:

- ⊕ Mobility,
- ⊕ Bandwidth,
- ⊕ Multimedia applications and resources,
- ⊕ Communication and collaborative applications, and,
- ⊕ Services to support all of the above.

We expect two unifying features to guide our initiatives:

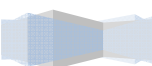
- ⊕ **Expanding** the ability to communicate and collaborate within schools, among schools, and between schools and external sources of information. The NYCDOE must be able to support the rapidly increasing number of devices (desk tops, laptops, iPods, hand held devices, etc.) that students and staff now use to communicate and collaborate with the rest of the world.
- ⊕ **Enhancing** the flexibility of the NYCDOE network and the technology options offered to schools by providing a robust technology platform while allowing individual principals the flexibility to pick and choose the right technology for their school communities.

The 5 year Strategic Plan demonstrates an awareness of the changing role of DIIT over the last 5 years. The Chancellor's **Children First** initiative continues to place more control in the hands of school principals. With the empowerment of school principals and the accountability that goes with it, DIIT seeks a new paradigm: a partnership with schools to provide customizable technology solutions and support available. DIIT will be available to advise educators and administrators on technology issues and, work with them to ensure that any technology choices they make can work well within the larger network infrastructure. In short, this document outlines a vision of how technology can enable and inform educational success, and describes a five-year plan for the NYCDOE infrastructure required to make that school visions reality.

## ***Trends in Education and Technology***

The technology choices outlined in this strategic plan focus on supporting the implementation of specific directions and trends in our schools, including the following:

- ⊕ Data-driven decision making resulting from the No Child Left Behind Act. New technologies and systems allow for more granular data gathering, assessments and accountability. Initiatives here rely on:
  - Secure remote access of data from desktop by school staff, students and parents.
  - Using systems to provide access to data, to help determine the success of teacher and administrator performance in the schools.
  - Fair student funding based on student data and teacher compensation.
  - Use of data for predictive look at what interventions will work for individual students.



⊕ eLearning and Virtual Schools as a means to enable transformative pedagogical methodologies via:

- A range of technology-oriented tools and services to enhance the receipt and delivery of instruction. eLearning can be leveraged to differentiate content delivery for School Support Organizations, networks, schools, teachers, students and parents without the logistical confines of 20th century traditional methodologies.
- Curriculum development for eLearning as means for delivery of courses that do not require the physical presence of students at high school enabling:
  - Availability of many advanced placement courses and flexibility for high school students.
  - Scheduling and classroom flexibility.
  - Extending student and teacher mobility, to allow education to take place in both traditional and non-traditional environments.

⊕ Online Instructional Resources

- Textbook publishers are rolling out electronic versions of textbooks at reduced cost making it easier to roll out updated versions.
  - The new generation of software and hardware supporting eBooks will allow users to take notes on top of the textbook pages without damaging the textbooks.

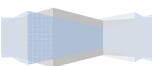
**Children First** seeks to create a system of outstanding schools where effective teaching and learning is a reality for every teacher and child. Technology is a key component for realizing the vision. Over the next five years, The NYCDOE's technological infrastructure will continue to meet the demands of this program, expanding the relationship between DIIT and a set of increasingly empowered schools as they attempt to transform their educational practice.

The five year strategic plan takes into account a number of significant trends affecting the technologies that the NYCDOE can implement.

⊕ Ubiquitous Access—Anytime, Anywhere, from Any Device:

The educational community is moving toward a mindset where access to network services and resources is needed in and out of the physical school. This is necessitating a focus on network resources, eLearning resources, and user devices for access.

- User Devices
  - Introduction into the educational environment of smaller and student-owned devices, exploiting student familiarity with such technology to further educational goals.
    - Design and implementation of innovative learning activities for use with these devices.
- Development and introduction of hybrid devices under \$400 fusing laptop, PDA and tablet technologies.
- Possible elimination of hard drives or CD ROMs on student machines.



- Total Cost of Ownership (TCO) will drop for the following reasons:
  - Hardware budgets for schools will be lower
  - Devices will be more bullet proof
  - Remote management tools to improve physical and logical security of machines, so that they are protected from viruses, and from tampering and misconfiguring by students.
  - Users are more knowledgeable and tech savvy, resulting in lower training costs.

#### ⊕ Software and Applications

- Reduction in system-owned software while enabling use of free Web 2.0 and open source tools.
- Software as a Service (SAAS) or “rented software” tools for users.
- Open-source Learning Management System (LMS) portals created with “best of breed” products.

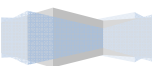
### **Cloud Computing**

Gartner <http://www.gartner.com> defines cloud computing as “a style of computing where scalable and elastic IT-enabled capabilities are delivered as a service to external customers using Internet technologies.”

In research published May 5, 2009, Gartner describes five attributes of cloud computing.

The attributes are:

- ⊕ **Service-Based:** Consumer concerns are abstracted from provider concerns through service interfaces that are well-defined. The interfaces hide the implementation details and enable a completely automated response by the provider of the service to the consumer of the service. In addition, the service could be considered “ready-to-use” or “off the shelf” because the service is designed to serve the specific needs of a set of consumers, and the technologies are tailored to that need rather than the service being tailored to how the technology works. The articulation of the service feature is based on service levels and IT outcomes (availability, response time, performance versus price, and clear and predefined operational processes), rather than technology and its capabilities. In other words, what the service needs to do is more important than how the technologies are used to implement the solution.
- ⊕ **Scalable and Elastic:** The service can scale capacity up or down as the consumer demands at the speed of full automation (which may be seconds for some services and hours for others). Elasticity is a trait of shared pools of resources. Scalability is a feature of the underlying infrastructure and software platforms. Elasticity is associated with not only scale but also an economic model that enables scaling in both directions in an automated fashion. This means that services scale on-demand to add or remove resources as needed.
- ⊕ **Shared:** Services share a pool of resources to build economies of scale. IT resources are used with maximum efficiency. The underlying infrastructure, software or platforms are shared among the consumers of the service (usually unknown to the consumers). This enables unused resources to serve multiple needs for multiple consumers, all working at the same time. For example, the Force.com platform uses sharing as a basic way to deliver economies.
- ⊕ **Metered by Use:** Services are tracked with usage metrics to enable multiple payment models. The service provider has a usage accounting model for measuring the use of the services, which



could then be used to create different pricing plans and models. These may include pay-as-you go plans, subscriptions, fixed plans and even free plans. The implied payment plans will be based on usage, not on the cost of the equipment. These plans are based on the amount of the service used by the consumers, which may be in terms of hours, data transfers or other use-based attributes delivered.

- ⊕ **Uses Internet Technologies:** The service is delivered using Internet identifiers, formats and protocols, such as URLs, HTTP, IP and representational state transfer Web-oriented architecture.

In consideration of the use of the cloud, Gartner recommends:

- ⊕ Consumers and providers of cloud services must examine the attributes of cloud computing to determine whether the services will deliver the expected outcomes.
- ⊕ Avoid discussions of what is and what is not cloud computing in favor of examining how much a given service can deliver the outcomes (value proposition) of cloud computing.
- ⊕ Consider what the scope of membership needs to be for private cloud computing and who will control the assets.

It is the intent of the NYCDOE to look toward economical and scalable infrastructure platforms. We will tailor our solutions strategically, according to the NYCDOE's educational business needs, and set the direction for developing standardized platforms. Platforms will leverage traditional infrastructure, as well as private and public cloud offerings where appropriate.

## **Web 3.0 (Semantic Web) and Internet Trends**

Part of the challenge facing NYCDOE technology planners is in predicting future directions for the Internet. This future environment has already been labeled Web 3.0, or Semantic Web, on websites.

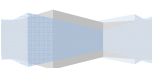
From W3C Semantic Web <http://www.w3.org/2001/sw/> (6/5/09):

*"The **Semantic Web** provides a common framework that allows **data** to be shared and reused across application, enterprise, and community boundaries. It is a collaborative effort led by W3C with participation from a large number of researchers and industrial partners. It is based on the Resource Description Framework (RDF).*

*The Semantic Web is a web of data. There is lots of data we all use every day, and it is not part of the web. I can see my bank statements on the web, and my photographs, and I can see my appointments in a calendar. But can I see my photos in a calendar to see what I was doing when I took them? Can I see bank statement lines in a calendar?*

*Why not? Because we don't have a web of data. Because data is controlled by applications, and each application keeps it to itself.*

*The Semantic Web is about two things. It is about common formats for integration and combination of data drawn from diverse sources, where on the original Web mainly concentrated on the interchange of documents. It is also about language for recording how the data relates to real world objects. That allows a person, or a machine, to start off in one database, and then move through an unending set of databases which are connected not by wires but by being about the same thing."*



**Internet traffic is already the most significant driver for WAN bandwidth demand at schools, primarily as a result of three trends.**

1. The inclusion of more multimedia-rich content as part of Internet traffic has greatly increased bandwidth demands.
2. A move to expand mobility in schools has led to more wireless computing devices as well as an expansion of locations where students can use computers. In the past, computer use was limited to stationary computers in computer labs. Now, wireless laptops allow the introduction of many more computers in schools, and wireless access has been extended to common areas, such as corridors, lounges, and school auditoriums, greatly expanding the opportunity for Internet use.
3. Internet usage has expanded to lower grades, primarily as multimedia applications have expanded. Five years ago, the NYCDOE thought that high speed WAN links would be required in high schools, but not elementary schools. That is no longer the case.

In addition, we expect future web-based applications to enhance collaborative work environments, a feature of particular value to educators.

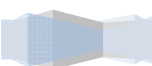
The expansion of Internet use has presented significant challenges to the design of school infrastructure, as the NYCDOE seeks to match LAN, wireless and WAN capabilities to the growing need that schools have for instructional Internet applications. Within the past year, this demand has extended to all grades, and has accelerated much more quickly than planned. It will also present challenges to school governance. As schools expand areas for wireless coverage, students will increasingly seek to replicate their home Internet environments in the schools. The NYCDOE has already seen spikes in Internet usage as a result of streaming video downloads of entertainment videos, such as music and movie trailers. For a high school with a high student population in New York, it would be difficult to support these applications and maintain the level of available bandwidth required for crucial instructional applications.

New developments in the Internet -- Web 3.0 -- are likely to change future demand as radically as audio and streaming video have changed it in the recent past. A key goal of the NYCDOE's technology plan is to ensure that its infrastructure can meet this demand.

## ***Design Standards and Methodology***

Although this strategic plan focuses on technical innovation in the NYCDOE schools, it should be understood that there is a long, complex process between the conception of such technological advances and their implementation in City schools. Between the process of defining the technology for a new service (e.g., Next Generation Wireless) and the implementation of that technology in a school, the NYCDOE provides a comprehensive, effective means for its realization.

In brief, each technological undertaking in the schools consists of four main phases: planning, design, implementation, and post-implementation and support.

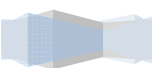


First, there is the planning phase, when the idea or service is formulated. Project Management plays an important role here, as it does throughout the project. Project Management ensures, among other things, effective resource management, and the timely completion of the school project implementation. Project Management is involved from the moment planning begins.

During the design phase, the proposed solution must adhere to the rigors of technical standards, which have previously been put in place by the NYCDOE.

With regard to implementation, the project must also adhere to the framework for solution integration; that is, there is a process in place for integrators to build out the necessary physical and logical framework that will support the technology in the schools. These elements should help to provide the necessary structure for the project.

The rigorous process described above must be able to be replicated in all targeted schools, as well as being extensible within a school; it must also be expertly deployed, and thoroughly and consistently supported by the NYCBOE and/or its vendors.



## SECTION 3: GUIDING PRINCIPLES

This five-year strategic plan is shaped by two broad sets of guiding principles: those embodied by the Chancellor's Children First initiative, aimed at altering the dynamic of the educational workplace by shifting the center of educational policy to the schools; and those focusing on the support of new directions in curriculum and instructional technology we envision in the next five years.

### ***Children First Intensive***

From the NYCDOE Website:

<http://schools.nyc.gov/AboutUs/schools/childrenfirst.htm>

### **New York City School Reforms**

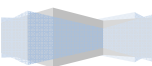
Mayor Bloomberg and Schools Chancellor Klein launched Children First, a comprehensive school reform effort, in 2003. Children First's goal is creating 1,400-plus great schools, where all of the 1.1 million schoolchildren in New York City are able to learn the skills and receive the support they need to realize their potential.

Mayor Bloomberg and Chancellor Klein believe education reform requires a comprehensive and integrated plan, involving changes in strategy, leadership, management, people, and programming.

### ***Children First Today***

*"Our mission over the next four years will be: To create—from pre-school through high school—a public education system second to none. We will strengthen the three pillars of our school reform: Leadership, Accountability, and Empowerment, putting resources and authority where they belong: in the schools of our city. And because the eyes of the nation are on our efforts, our successes hold the promise of hope for schools across the land. What a wonderful gift for New York to share with the rest of our country."*

**- Mayor Michael R. Bloomberg, January 1, 2006**



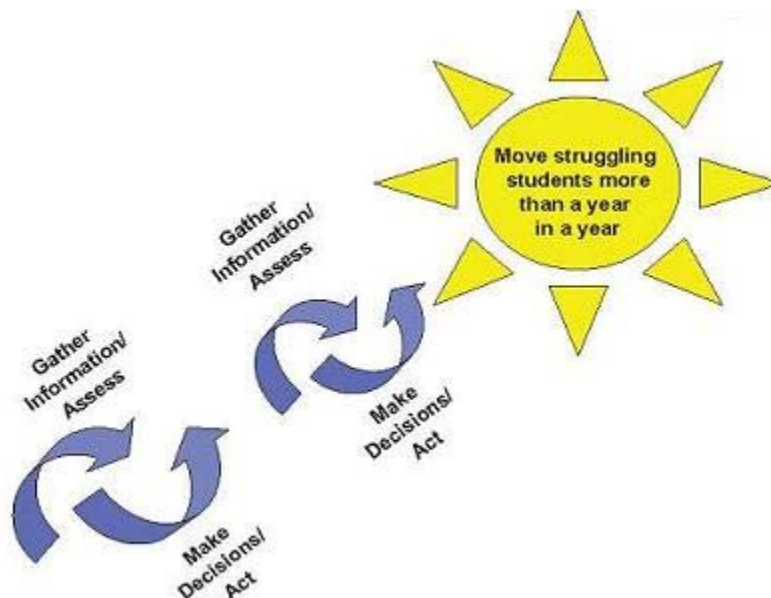
## Children First Intensive

The Children First Intensive (CFI) is a professional development program that supports school leaders and teachers to thrive in the Department of Education's new environment of empowerment and data-driven accountability. The mission of CFI is to support each school in closing the achievement gap and expanding its sphere of success.

**Children First Initiative engages in the following activities:**

- ⊕ Disseminates knowledge about the concepts behind the Children First Reform, including the Accountability Tools:
  - Progress Report
  - Quality Review
  - Periodic Assessments
  - ARIS
- ⊕ Trains Senior Achievement Facilitators (SAF) to help schools integrate the Accountability Tools into school planning.
- ⊕ Develops school-based Inquiry Teams that engage in a process of deep self-study using quantitative and qualitative data. Made up of teachers and administrators, the teams select a target population of struggling students. By investigating the changes needed to accelerate these students' progress, Inquiry Teams reflect on and inform the structures of learning within the school as a whole.

**Figure 3-1: CFI Overview**





To learn more about the Inquiry Team process, please download our brochure.

### CFI Organizational Structure

Each SAF partners with a School Support Organization (SSO) network to support 20-25 schools. SAFs lease primarily with the Inquiry Teams at each school.

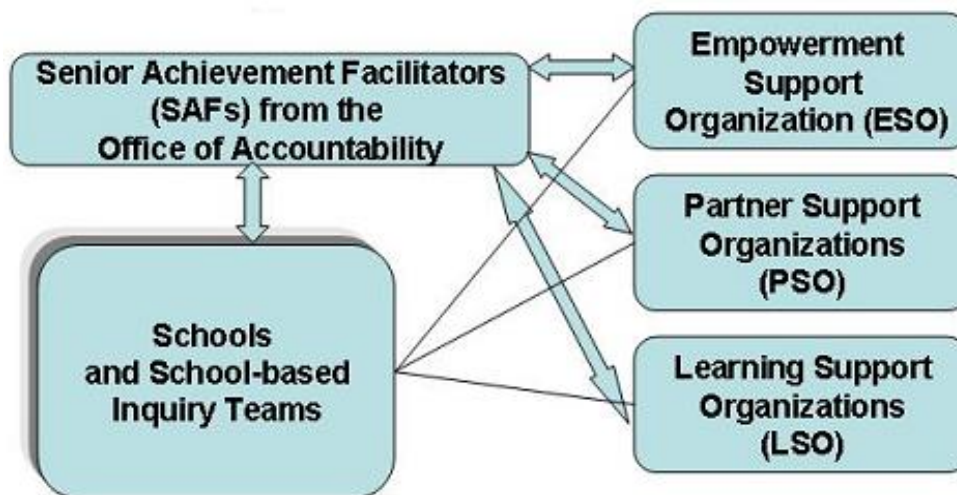


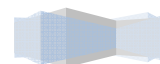
Figure 3-2: CFI Structure Overview

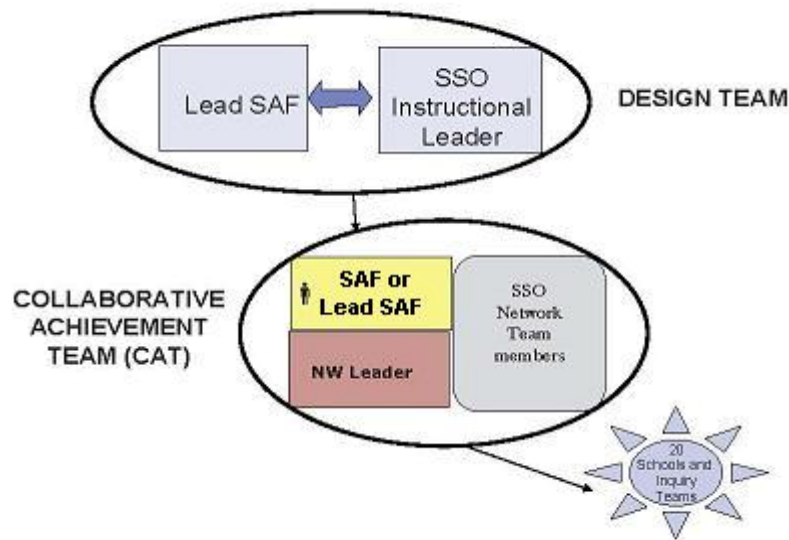
### What are the responsibilities of the Senior Achievement Facilitators?

- ⊕ SAFs work intensively with groups of schools to develop, align, and deliver **training** in support of improved student learning.
- ⊕ SAFs identify, disseminate, and facilitate effective practices that **use the accountability tools** and other tools to differentiate instruction and improve outcomes for all children.
- ⊕ SAFs act as a **feedback loop** between schools and the Office of Accountability.

### How do Senior Achievement Facilitators work with School Support Organizations?

- ⊕ One SAF working with each SSO is designated the Lead SAF. This individual works closely with the SSO instructional leader to bring alignment between instructional initiatives and accountability tools.
- ⊕ Lead SAFs and SSO instructional leads citywide meet in monthly Design Team meetings to develop professional development for the SAFs and network teams. Each Lead SAF and SSO instructional lead refines these plans in order to best fit their SSO.
- ⊕ Each network team in the SSO meets with their designated SAF to form a Collaborative Achievement Team (CAT). Together they strategically plan for the development of the 20 to 25 schools they service.





**Figure 3-3: SAF and SSO**

#### From the DOE website:

The Achievement Reporting and Innovation System (ARIS) is a first of its kind innovation system that applies assessment, analytics and reporting tools with goals of:

- ⊕ Empowering educators to improve student outcomes
- ⊕ Transforming information into improved classroom practice
- ⊕ Stimulating, capturing, validating, and disseminating innovation

ARIS provides educators with a consolidated view of student learning-related data and tools to collaborate and share knowledge about how to accelerate student learning.

### ***Professional Development***

The NYCDOE fosters a collaborative community of learners by providing resources and information to staff, students and parents. A major part of this collaborative involves opportunities for professional development for the improvement of instructional practice. Schools are able to customize professional development within their own environments utilizing their own resources. Central Teaching and Learning also provides opportunities for schools to leverage for staff in honing skills sets.

We recognize that lack of time and funding often are a detriment to getting the most from professional development offerings via the NYCDOE and vendors. We also recognize that we have talent and resources within our own environment which can be honed and shared across the enterprise. The vehicle for this is the Internet via a comprehensive learning management system that can be accessed 24/7 for a customized and individual professional development experience.

- ⊕ Design and implement a *flexible*, open source learning management platform to provide resources, tools and how-to instructions for the entire NYCDOE community.

- This platform, or portal, will provide all segments of our educational community with a single point of access to appropriate levels of content for professional development and student instruction.
- Our community will use this portal for provision of valued resources.

⊕ Provide adequate skills and support for key applications and infrastructure areas

### **Division of Accountability and Achievement Resources**

NYC is proposing alignment of Professional Development delivery to School Support Organization (SSO). Schools have long benefited from support and assistance from people outside the building to help identify best practices in education; to provide targeted strategies for specific students in need of extra help; and to help prioritize among competing demands on resources and time. To ensure that the support from outside the school is consistent with and advances the school's priorities and focus, school leaders need the ability to choose the kind of support that best meets their needs.

Our grant program will leverage powerful network teams to embed instructional technology resources and professional development into the work of participating schools. Title IID staff will provide technical support, professional development, and expertise in instructional technology and network team staff will support schools in embedding these resources and support into educators' daily practice.

### **Title IID Grant Alignment of PD delivery**

Professional development will take place in an on-going manner over three years, and will build each year to a culmination in which the grantee schools are in a position to share their learning through a virtual community, and therefore offer professional development resources that will be available beyond the life of the grant. Below is the selection of offerings identified under each theme.

### **Leadership & System Change through Tech Innovation**

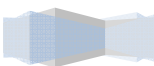
- ⊕ Leadership 360: Leading in a 21st Century School
- ⊕ Creating a School-wide Project Based Learning Curriculum Using Curriculum Mapping
- ⊕ Digital Media and Graphic Arts
- ⊕ Digital Media within Content Areas
- ⊕ Partnering with Digital Natives - Engage 21st Century Students by Helping Teachers

### **Change Pedagogy with Technology**

- ⊕ Performance Assessments using ePortfolios
- ⊕ Using Online Learning to Meet Student Academic Needs in Credit Recovery, Regents

### **Preparation & College Level Opportunities**

- ⊕ Developing Academic Writing Skills w/Online Auto-Essay Scoring
- ⊕ Accelerating Students' Skills Acquisition with Self-Paced Supplemental Formative



## Assessment and Instructional Programs

The professional development component of this project focuses on:

1. Supporting school leadership to assess their development in ELA along the dimensions of a 21<sup>st</sup> century school.
2. Identifying, implementing, and capturing learner-center innovative instruction in ELA.
3. Conducting focused inter-visitations through the Dimensions of a 21<sup>st</sup> Century School framework that will inform movement across the continuum and identify innovative ELA practices.
4. On-site instructional support in the development of a literacy action plan designed to move schools along the 21<sup>st</sup> Century continuum with innovative practices observed at model schools.
5. Preparing teachers to work effectively with Professional Learning Communities utilizing the technology to support planning, team building, and leadership skills.
6. The development of 21<sup>st</sup> century learning skills.

### Technology Infusion into Instruction through Professional Development

- ⊕ Enhancing Science & Math Exit Projects Using Web 2.0 Tools
- ⊕ Enhancing Social Studies Exit Projects Using Web 2.0
- ⊕ Engaging Student & Accelerating Learning through Project-Based Learning
- ⊕ Developing Teachers' Skills in 21st Century Instructional Practices Using Video
- ⊕ Performance Assessments Using ePortfolio
- ⊕ Student Skill Acquisition
- ⊕ Using Online Learning to Meet Student Academic Needs in Credit Recovery, Regents Preparation, and College Level Opportunities

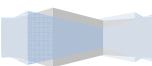
The professional development components outlined and described include:

1. Institutes and forums for leaders and teachers focused on theory and practice in creation of student centered 21st century schools and classrooms.
2. Facilitation and preparation of successful mentor schools selected to host focused and guided learning walks and lab-sites.
3. Embedded onsite support in grant schools to help leaders and teachers self-assess, reflect on practice, plan, and implement classroom and virtual lab sites.

### Data-Driven Differentiated Instruction and Learning

Coherent Instruction Project: Using Data to Align Curriculum, Assessment, and Instruction—Focusing on Digital Media.

- ⊕ Capturing Teacher Data Driven Instruction Practices with Digital Video
- ⊕ Developing Academic Writing Skills w/Online Auto-Essay Scoring
- ⊕ Accelerating Students' Skills Acquisition with Self-Paced Supplemental Formative Assessment and Instructional Programs
- ⊕ Performance Assessments using ePortfolios—Focusing on Digital Media



## ⊕ Creating a School-wide Project Based Learning Curriculum Using Curriculum Mapping

### **The professional development component of this project will focus on:**

1. Preparing administrators, teachers and students to utilize data effectively.
2. Preparing participants to work effectively within the Professional Learning Communities utilizing the technology approach to support planning, team building and leadership skills.
3. Development of 21<sup>st</sup> Century Learning Skills will be embedded into all professional development.

## *Teaching and Learning*

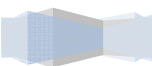
### **Office of eLearning**

#### **Creation of Virtual Learning Environments:**

Research indicates that immersive virtual environments are powerful tools of experiential learning that increases student achievement. Medical universities, the aerospace industry, and the military are just some of the institutions that have significantly invested in virtual environments to provide a style of learning that meets the needs of today's student. In the K-12 realm, software publishers and schools districts are racing to incorporate immersive learning into the curriculum. Our students will be provided with proven instruments of virtual learning that engage, motivate, and excite students towards success in mastering all content areas.

#### **Development of a Professional Development Learning Content Management System (LCMS):**

There is a great disparity in the professional development needs and modes of delivery amongst individual schools within the DOE. Schools are not only challenged with finding professional development services that can be applied to their specific instructional settings, but are also challenged with time and location constraints. The Office of eLearning Services will work collaboratively with the Talent Office to identify a LCMS partner; and develop online courses that allow participants to learn at their own pace, in a variety of modes best suited to personal learning styles, at a remote location, at any time. In addition, the amalgamation of current core curriculum teaching strategies within simulated learning environments will allow participants to acquire real knowledge in a real-world context that is often hard to replicate with limited 20th century tools. Lastly, eLearning's professional development offerings will take into consideration the ways in which school inquiry teams address specific needs or challenges in their respective school through the analysis of many data and assessment types. Our training modules will depict what schools are currently doing to improve student achievement, and respond to their unique instructional circumstances.



## Development of an Online Core Curricular Support:

The Office of eLearning will instruct participants on how to integrate twenty-first century technology innovations into teaching and learning through online learning communities, project based learning and virtual environments that support student success.

### ***We will:***

1. Provide support and resources for online learning communities to collaborate around integrating technology into curricula and instruction.
2. Develop resources to support the integration of instructional technology into the citywide implementation of the core curriculum.
3. Partner with several innovative technology-base curriculum projects in the core content areas.

## Teaching and Learning

Some of the directions that this technology plan will support are identified through the curricular pathways as identified through numerous Teaching and Learning initiatives for all students.

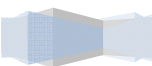
Success for students in our school system relies on the acquisition of “21<sup>st</sup> Century Skills” in order to compete in the global work force of the present and near future. The Partnership for 21<sup>st</sup> Century Skills <http://21stcenturyskills.org> lists the following reasons:

1. *Education is changing*—students from countries around the world are outperforming American students on assessments measuring 21<sup>st</sup> century skills.
2. *Competition is changing internationally*—Innovation and creativity are found globally, forcing new economic competition.
3. *The workplace, jobs and skill demands are changing*—Students in all careers will need mastery of 21<sup>st</sup> century skills to succeed in this new global economy.

The following outlines the need for student skills sets needed to succeed in work, school and life. The Partnership for 21<sup>st</sup> Century Skills defines these skills as:

- ⊕ Core subjects (as defined by NCLB) mastery in contemporary context
- ⊕ 21<sup>st</sup> century content: global awareness, financial, economic, business an entrepreneurial literacy, civic literacy, and health and wellness awareness
- ⊕ Learning and thinking skills: critical thinking and problem solving skills, communications skills, creativity and innovation skills, collaboration skills, contextual learning skills and information and media literacy skills
- ⊕ Information and communications technology literacy
- ⊕ Life skills: leadership, ethics, accountability, adaptability, personal productivity, personal responsibility, people skills, self-direction and social responsibility

A common thread in the areas on this list is that students will need to have the ability to effectively access, analyze, and communicate information. The NYCDOE’s plans for technology are geared toward



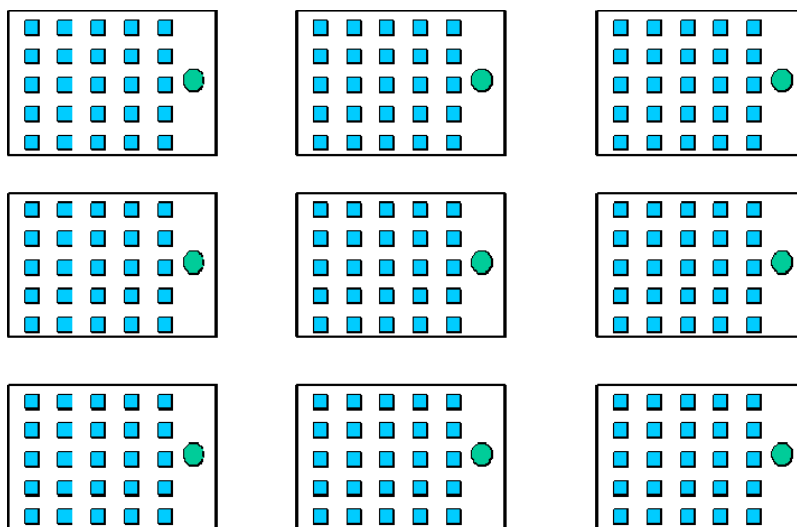
meeting these needs, both in the area of instructional goals and career and technical education.

## *Curriculum and Instructional Technology*

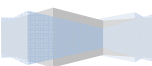
### **Transformation of the Learning Environment from Industrial Model to 21<sup>st</sup> Century Model:**

- ⊕ School focus to transform learning environments from an industrial, one size fits many, teacher-centric model to a dynamic, learner-centered model which leverages more dynamic learning environments.

#### **Industrial Model**

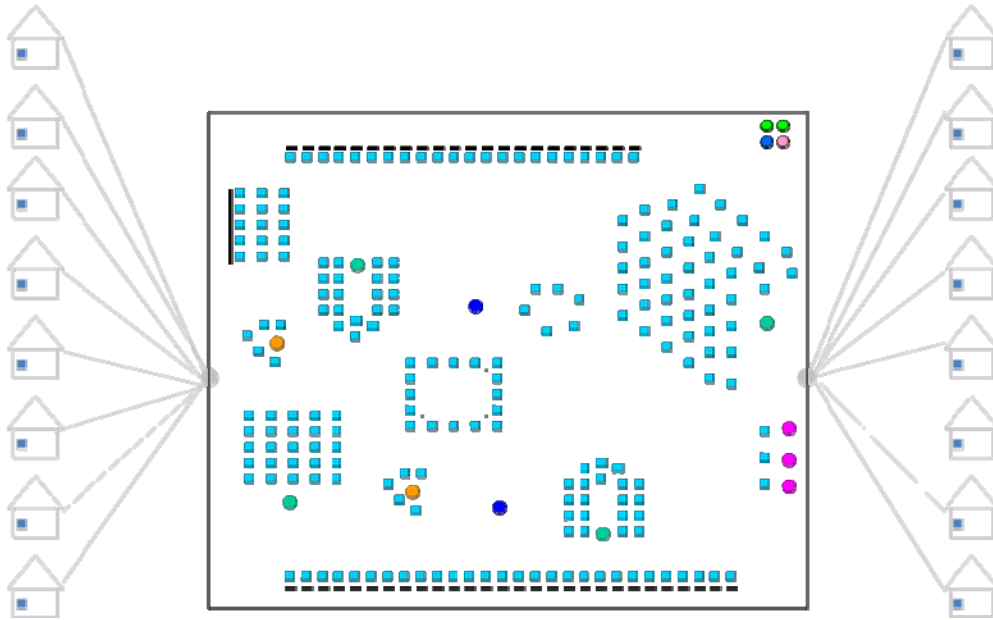


**Figure 3-4: Industrial Model**



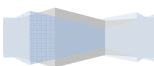
## 21<sup>st</sup> Century Model

**By leveraging multiple learning modalities, students can receive instruction differentiated to their particular needs and learning styles.**



**Figure 3-5: 21<sup>st</sup> Century Model**

- ⊕ Today, schools are structured for an industrial model that is no longer relevant to students' lives. The industrial school model, dominant for more than a century, relies on classroom standardization; batch and print learning.
- ⊕ The move is to a differentiated approach to learning experiences within core content areas.
- ⊕ Devices in the hands of every student (sub-laptops, mobile devices, etc.)
- ⊕ Bring professional development closer to the school level
  - Localizing PD for individual schools
  - Leveraging Central staff by working with a point person at each school
- ⊕ Formalized assessment for assessment of instructional technology integration into teaching and learning.
- ⊕ Communicate, Collaborate, and Create.
- ⊕ Develop *Virtual Structures* for content area teaching and learning.





## Some Teaching and Learning Goals and Objectives

- ⊕ Assist schools with employing instructional technology solutions to meet instructional objectives
- ⊕ Work closely with curriculum offices to design professional development opportunities that support the current curriculum.
- ⊕ Support the development of library programs that build independent learning skills and reading motivation in all students.
- ⊕ Foster the integration of library resources, technology, and the teaching of information skills into the learning process in all content areas.

## NYC21C Initiative

The 21st century knowledge-based economy where they will spend their working lives is increasingly competitive and driven by technological innovations.

We need to give them the intellectual tools and practical skills to succeed in that world.  
We need a new model for 21<sup>st</sup> century schools.

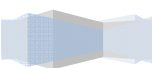
**The Problem:** Today, schools are structured for an industrial model that is no longer relevant to students' lives. The 21st century knowledge-based economy where they will spend their working lives is increasingly competitive and driven by technological innovations. We need to give them the intellectual tools and practical skills to succeed in that world.

**The Vision:** Transform our schools from a traditional, industrial model to one that reflects and embodies 21<sup>st</sup> century skills, tools, and experiences, so that our students graduate ready for success in college and in the workforce, regardless of race, language or socioeconomic background.

## NYC21C Model Schools

A two-pronged effort to produce a comprehensive and effective model for 21<sup>st</sup> Century learning:

- ⊕ Individualized Learning Platform
  - Leverage state-of-the-art technology to personalize instruction in core academic skills
- ⊕ School Model Development
  - Invent, codify, and replicate the most effective school wide practices that prepare students for 21<sup>st</sup> Century



## Facilitating Networks to Share Knowledge and Best Practices

### School Model Development

School model development is focused on capturing and replicating a core set of schoolwide practices designed to transform schools into personalized places for the 21<sup>st</sup> century learning.

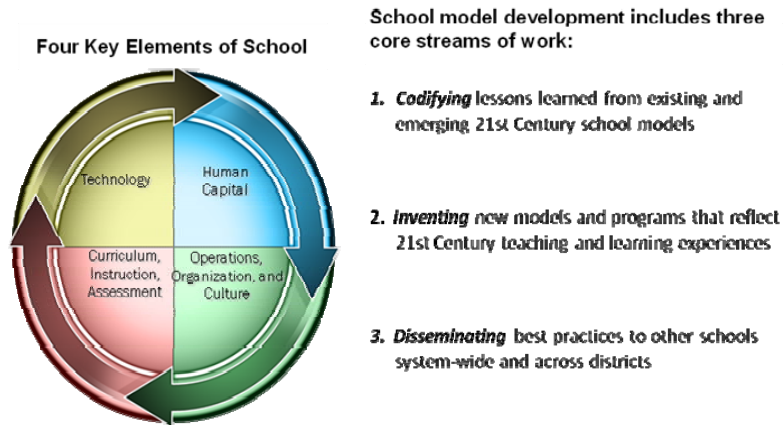
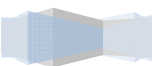


Figure 3-6: School Model Development



## NYC21C 5 Year

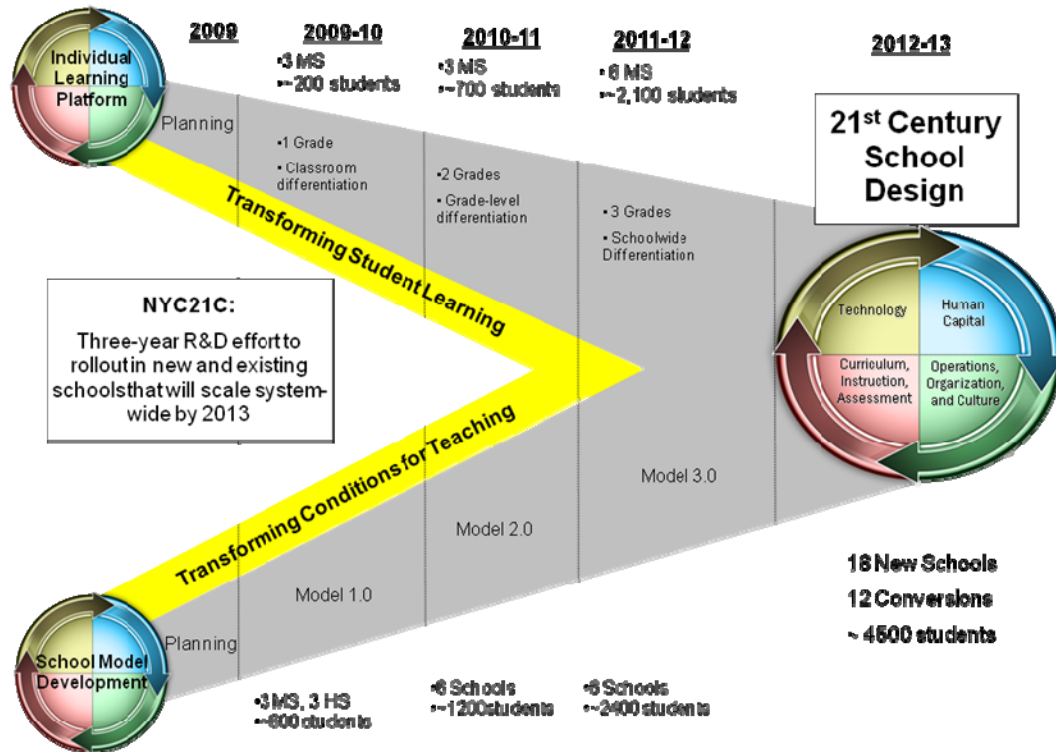
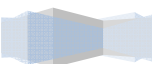


Figure 3-7: NYC21C 5-Year Overview



## ***Career and Technical Education***

### **From the NYCDOE Website:**

High Schools with Career and Technical Education (CTE) programs integrate rigorous academic study with workforce skills in specific career pathways. Students participate in programs that meet business and industry standards. Students receive instruction in an industry-related area and have the opportunity to graduate high school with industry-specific competencies and skills that lead to postsecondary education, further industry training and/or entry into the workforce.

Currently, over 125 schools offer more than 320 CTE program pathways. Thirty designated “CTE schools” enroll approximately 30,000 of these students; the remainder attends comprehensive high schools around the city including small schools, specialized high schools, and schools with small learning communities. Etc.

In 2001, NYSED introduced a CTE program approval process to foster high quality career and technical education programs. Seventy-one (71) programs in New York City are currently approved by the State, and reflect elements of enhanced quality and student outcomes. Students completing a State approved program of study are eligible for a technical endorsement on their diploma.

### **Mayoral Task Force on CTE Innovation**

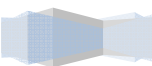
In his January 2008 State of the City address, Mayor Bloomberg made career and technical education (CTE) innovation a city-wide priority, announcing his commitment to improve student achievement in this area and charging a mayoral task force to report findings and recommendations on ways to improve CTE and contribute to continuing gains in the City’s overall high school graduation rate.

### **21<sup>st</sup> Century Pedagogy in the New York City Public Schools**

- ⊕ Teachers acts as facilitators, resources and partners for teaching and learning integrating 21<sup>st</sup> century skills.
- ⊕ Assessments reflect 21<sup>st</sup> century skills which are tracked over time.
- ⊕ Parents, teachers and students use assessment information in collaboration to monitor student progress.
- ⊕ Professional development is designed and organized around all of the above.
- ⊕ School administrators align vision to 21<sup>st</sup> century skills development an acquisition.

### **Learning Management System**

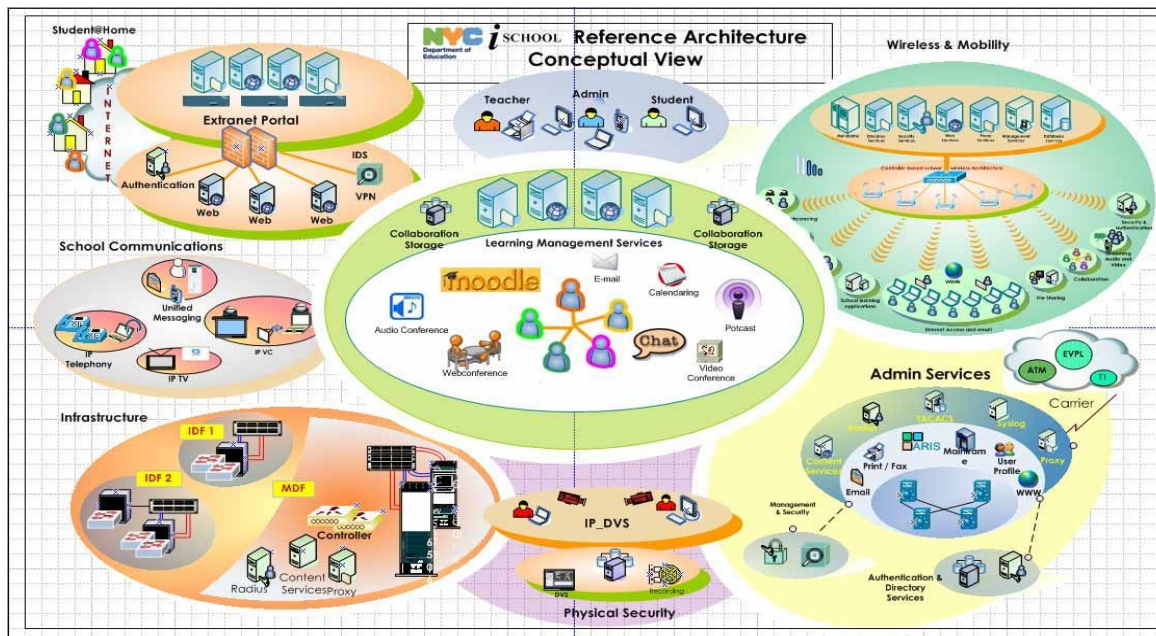
Development of a robust and comprehensive eLearning platform to facilitate content delivery for professional development and instruction for students



## Content Delivery Architecture Requirements

Any open source tool selection should align with the overall NYCDOE Enterprise Architecture strategy.

### Preliminary proposed Learning Management Model:



**Figure 3-8: Learning Management Model**

A ubiquitous instructional portal allows students, teachers to collaborate and access same resources inside or outside the school.

Principals and/or teachers can monitor student e-mail contents and share files.

### High level Open Source tool requirements:

- ⊕ Secure user login.
- ⊕ Display Study group projects.
- ⊕ Be able to track on-going projects.
- ⊕ Be able to reference project/work from the previous years.
- ⊕ Be able to access recorded SME/field expert videos.
- ⊕ Be able to share notes from teachers and field experts.

Principals and teachers need real-time monitoring and parents should allow partial monitoring of their kids' classroom work and online homework.

## ***Special Education***

### **A. Vision**

A transformation of special education focusing on service quality and student outcomes using technical initiatives targeted at the school level.

The NYCDOE seeks to provide special education data systems that improve special education student data integrity, and clearly report student outcomes, thus empowering schools with increased autonomy; and in return, increasing school accountability for improving student outcomes. Initiatives to reach this goal include the delivery of applications that reduce costs to capture, process, manage, archive and report accurate and timely special education data.

#### ***This will enable the DOE to:***

- a. Increase compliance by providing timely and accurate State and Federal reports; reduce the total number of Due Process/other litigation in which the NYC Department of Education (NYCDOE) must settle or lose due to poor management and compliance processes.
- b. Define and design a configurable and adaptable solution that provides the NYCDOE with a sustainable approach for developing, maintaining and operating the special education solutions that aligns with, and furthers, the NYCDOE IT Enterprise Architecture.

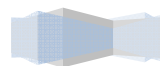
### **B. Industry Trends**

#### **a. In Education**

State and Federal legislation mandates inclusive education, resulting in inclusive service-delivery models, with general education teachers finding more and more students with disabilities in their classrooms for a larger portion of the day, and Special Education teachers finding themselves more frequently in support roles to the general education classroom and teacher. Teachers and teacher educators will need preparation and retooling to stay abreast of the needed changes in service delivery.

Given the increasing demand for special education teachers, personnel preparation programs have found it necessary to intensify their use of time and resources. There will be a greater need for educators to collaborate and to share their expertise.

Children are receiving special education earlier, expanding the population of special education students. In addition, people with even severe handicaps are willing and able to work, expanding the need for vocational special education.



As a result, there is an augmentation and change in the role of school psychologists, reducing psychometric activities in favor of intervention-based assessment (IBA), which involves planning and evaluating intervention services for children with learning and behavior problems.

Districts are placing increasing emphasis on intervention and prevention of disabilities which not only benefit children in the long run, but save money as well by reducing the later need for costly services.

Additionally, breakthroughs in learning styles, assessment, treatment, identification, and learning theories are expected to produce changes to special education operations and support.

b. In Technology

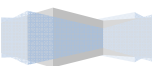
Service Oriented Architecture (SOA) implemented through the web allows for orchestration of services, composite software functions--such as enrolling a student, to be executed on demand by any system, without regard to its operating system, platform, programming language, or geographic location.

The development of Enterprise Data Structures – with shareable resources across the enterprise - will allow for streamlined and improved data sharing and development of appropriate and individualized interventions for students.

**C. Future Plans and Recommendations**

Over the next 5 years the NYCDOE will accomplish a migration of all special education students to one integrated Special Education System (SEIS) from CAP/SEC allowing the NYCDOE to retire CAP and SEC. To further streamline data operations, the DOE plans to automate the collection and processing of special education IEP documents, including the integration of data collected on offline devices, such as laptops and handheld devices. The new SEIS system will include pre-school and non-NYCDOE students, eliminating the need for manual and redundant information management systems and processing.

These initiatives will allow the NYCDOE the opportunity to increase compliance with State, Federal mandates as well as other legal rulings with respect to delivering special education services to the NYC special education student population. The technical environment described in this section will scale to support NYCDOE enterprise-wide initiatives for document management, enterprise service bus, web services and operational data stores.



## D. Stakeholder User Cases

In 5 years, stakeholders will benefit from the following:

### a. Instructional

Teachers will improve the efficiency of in-school special education processes with tools, best practices and solutions which clearly are helping teachers and principals improve services and outcomes for student with special needs.

Central will continue to research and introduce best practices and new programs in helping teachers and related services deliver higher quality services.

### b. Administrative

Central support will continue to update and evolve data and process in the SESIS, deploying policies and procedures to all schools and support structures including ISCs, SSOs and Community School Districts through the efficient and timely solution configuration of SESIS. Finance officers and administrators will effectively manage the hundreds of millions of dollars contracted with vendors and independent providers engaged to deliver related services, focusing on quality of service and performance, thereby increasing the value delivered to the NYCDOE.

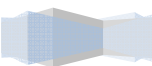
In compliance with State-mandated and other compliance reporting mandates, administrators will reduce service costs and improve resource planning of actual provider case load and utilization and achieve equity in students' access to services and in schools responsibility to serve their "fair share" of students. Schools and District Central functions will define and manage to key measures, and ensure objective data and performance procedures are implemented across the City.

### c. Services

Related services providers will be able to easily capture records documenting services delivered to students, student and service provider attendance, and any interim results and observations used to evaluate the student outcomes. Case managers will be able to implement on IEP (Individual Educational Profile) quality and special education operations improvement. This will result on much better case and resource management.

### d. Community

Parents will have the ability to participate more in the special education process of their children, through multiple contact mechanisms and languages offered through the NYCDOE notification and outreach functions. Community School Districts will provide access to a neighborhood-based grouping of schools allowing students to go to school closer to home. This will enhance the special education experience for students and parents.



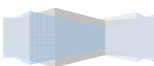


## **E. Benefits and Impact**

Initial implementation of SESIS – which is an enterprise operational data store - across the NYCDOE enterprise, will simplify many Special Education operations, procedures and services. The initial implementation of an enterprise service bus capable of scaling to additional web services to be implemented across the NYCDOE enterprise, further enhancing services. These initiatives will greatly reduce the total cost of NYCDOE Special Education operations. The NYCDOE will realize improved outcomes and higher levels of satisfaction for special education students.

Simplified processes supported by one integrated application framework will decrease paperwork and manual processes to support the special education process. This will allow for increased visibility of student enrollment and placement, providing better information to assess program effectiveness. Additionally, there will be better notification of incoming special education students and associated needs with immediate access to student records and IEPs, allowing for better onsite service.

SEGIS allows for migration to a more service-based, collaborative environment for special education providers from the current District-based hierarchical control structure. It reduces the number of due process requests in NYC, and decreases the total number of legal cases in which the NYCDOE must settle or lose due to poor management and compliance processes. Additionally, SESIS improves data integrity and helps lower the amount of data cleaning required to meet court mandated, State and Federal reporting requirements, including reporting activities that drive student funding.



## SECTION 4: SCHOOL INFRASTRUCTURE

### ***Vision***

NYCDOE K-12 educational needs describe an environment designed and organized around individual student learning needs and preferred learning styles. Technology is seen as a vehicle to greatly enhance and augment this differentiation through ubiquitous access to network applications and services that are available anywhere, anytime, from any device for students and staff. As well, students are now viewed as producers and consumers of rich digital media and online content.

The shift in instructional focus to individual needs and differentiated learning styles means that teachers must meet the educational needs of students in a much more customizable way. Technology again is seen as the means to achieve instructional goals in a more efficient and *transformative* way moving from an industrialized method of teaching many by focusing only on what the majority need at the expense of the few, to a more dynamic and highly individualized manner fostering mastery of 21c Skills. According to the Partnership for 21<sup>st</sup> Century Skills <http://www.21stcenturyskills.org/>,

*“...21st century teaching and learning...combines a discrete focus on 21st century student outcomes (a blending of specific skills, content knowledge, expertise and literacies) with innovative support systems to help students master the multi-dimensional abilities required of them in the 21st century.”*

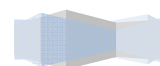
In addition to anytime, anywhere access to network applications and services, teachers need easy access to data, resources, shared knowledge base and professional development opportunities. Teachers need to personalize the instruction while providing for authentic learning experiences using the latest tools for collaboration and communication with students and peers.

In order to support these educational goals and objectives for 21<sup>st</sup> Century learning environments, the NYCDOE needs to provide a technological infrastructure that will allow for productivity, innovation and individuality for all schools. The plan for school infrastructure is designed to meet present-day requirements with an eye toward scalability over 5 years. This section focuses on the specific modifications and enhancements to school infrastructure that are necessary to allow for optimal educational success for all students in all schools.

### ***Goal and Strategy to Obtain Vision***

#### **School Technology Infrastructure:**

- ⊕ Implement and refresh school network infrastructure to support new enabling technologies: 5 year plan to refresh technology, including upgrading the network infrastructure to increase school WAN bandwidth, employ WAN backup redundancy and WAN optimization services with quality of services to support enabling technologies.



- ⊕ Implement enabling technologies, including Unified Communication and Collaboration (UCC), Learning Content Management System (LCMS), Virtual Desktop Infrastructure (VDI), and a 100% wireless coverage footprint in schools.
- ⊕ Implement enabling technologies to support digital and data content management.
- ⊕ Provide support for elearning programs in instruction and professional development.

## *Current State*

Currently, ninety-eight percent of the classrooms within the NYCDOE school buildings have Internet access and Wireless LAN connectivity. Each building has a cabling infrastructure consisting of a fiber optic backbone providing connectivity between the Main Distribution Frame (MDF) and Intermediate Distribution Frames (IDFs). Each classroom has multiple data ports and one voice drop, connected to an IDF or MDF. The MDF is the main voice and data telecommunications room where local and wide area networking equipment is installed (note, IDF's also have local networking equipment installed).

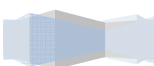
Schools are connected to a high bandwidth fiber optic ring to access critical NYCDOE resources, such as HSST, Galaxy, FAMIS, ATS and HR systems. This Synchronous Optical Network (SONET) Ring was built over the last five years and was designed with seven geographically distributed nodes to balance the number of connected schools across NY. Currently, schools are connected to the closest node within their associated borough by one of three WAN technologies: Frame Relay, ATM and EVPL. The SONET Ring build-out was part of an earlier strategic plan, and provides bandwidth capacity and redundancy required to support the needs for new instructional applications, and the growing number of PCs and laptops in schools into the future.

Currently, there are approximately 550 schools connect to the SONET Ring over Frame Relay, 225 schools over ATM and 350 schools over EVPL technology. All schools have a single WAN link connected to the NYCDOE core SONET Ring. In the event of a WAN failure, affected schools will immediately lose access to Internet resources. Schools currently do not have redundant WAN connectivity.

## *Target State*

**Our plan is to expand the current infrastructure to create a more robust and flexible school infrastructure to support new technologies.**

An adaptable, scalable, secure, and manageable infrastructure architecture is imperative for schools to meet demanding technology enhanced goals and objectives. High-speed transport services to support students, teachers and administrators across both Instructional and Administrative locations are required. The NYCDOE is committed to providing a robust and scalable school network infrastructure for all 1500+ schools.



## Future Enhancements:

- ⊕ High-speed WAN connectivity from schools to the NYCDOE core network for Internet and business application access.
- ⊕ Common backup WAN connectivity from schools to the NYCDOE core network.
- ⊕ Common intelligent network components, such as WAN optimization services to reduce bandwidth utilization for enhanced user experiences.
- ⊕ Common enhanced network services components, such as IP telephony, Content Delivery Network (CDN), and Streaming Media Services to support rich media traffic, digitized video and video broadcasting services.
- ⊕ Increase wireless coverage to include common areas in schools.
- ⊕ Access to network resources anywhere, anytime, from any device.

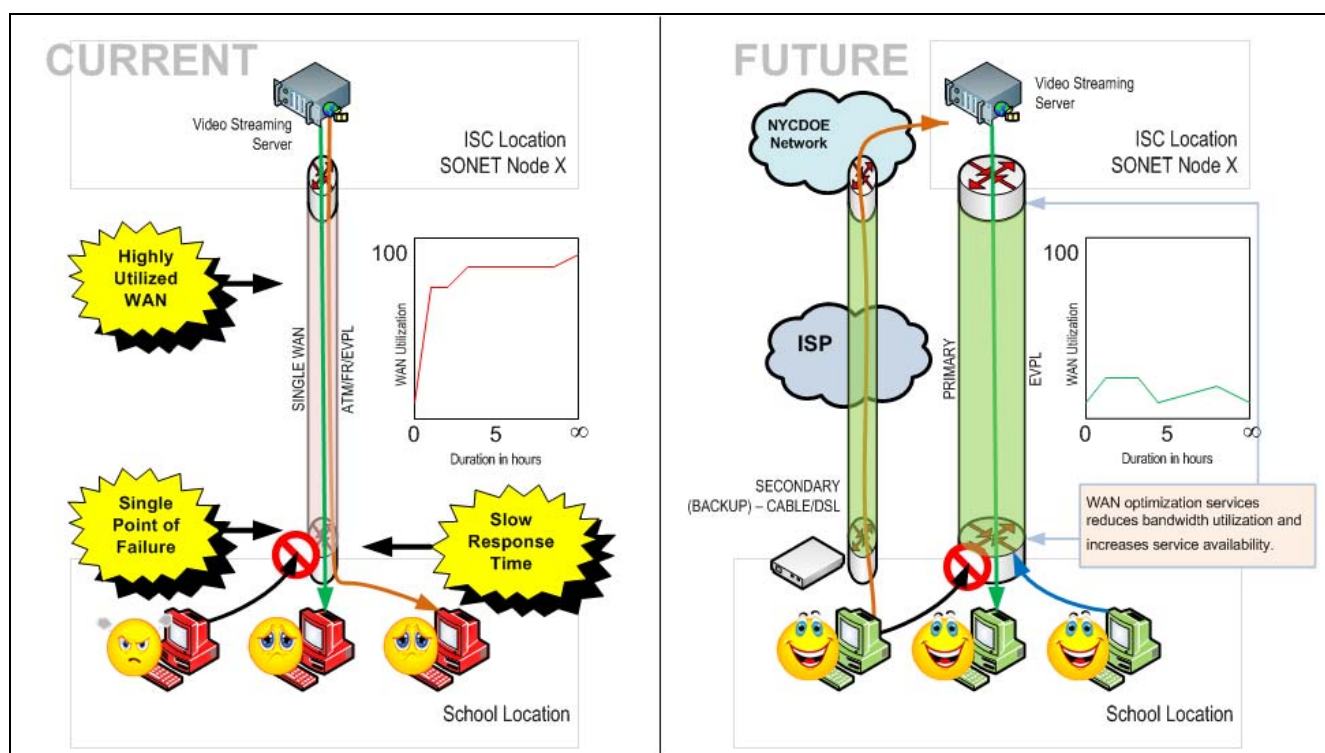


Figure 4-1: School WAN - Current and Future State

## Recommendations and Roadmap

The following recommended initiatives or projects are essential to obtain the vision

### Initiative 1: School Network Infrastructure Upgrade

The NYCDOE school network infrastructure is designed to meet the needs of users in our schools. While internet access is essential to teaching and learning, it introduces security risks making the environment susceptible to malicious software, identity theft and virus attacks—potentially, affecting end-user overall

experience and systems health. Additional levels of management and security are needed to ensure high availability and optimal service for critical applications.

Infrastructure enhancements, which include the WAN bandwidth upgrade, WAN backup redundancy and WAN optimization services, are needed to support the new instructional and business applications. The support and maintenance of the NYCDOE network infrastructure are critical in providing a consistent, replicable, scalable and supportable environment.

### **Initiative 2: School Infrastructure Facility Upgrade**

Although the schools' current MDF, IDF and infrastructure facility, including electrical and cabling environments have served us well, upgrades at some schools are necessary to provide effective management and efficient control of new and existing supported technologies. This will ensure services are provided with high-availability and efficient use of technology, lowering the overall total cost of ownership in supporting the schools of tomorrow.

#### ***Key Benefits:***

- ⊕ Provides a sustainable infrastructure for a greener environment.
- ⊕ Enables an extensible architecture to support new technologies and future growth.

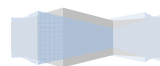
It is critical for the School Construction Authority (SCA) to review and approve the infrastructure facility upgrade plan. This will ensure the new standards are governed and enforced in partnership with DIIT. The new model will be applied to new constructions and retrofitted into existing schools.

### **Initiative 3: Expanded Wireless Footprint**

To augment the wireless coverage of the current wireless service deployment, installation of wireless access points in hallways and other common areas provide teachers and students ubiquitous access to network resources while allowing for greater mobility. This provides for the demand for dynamic and different learning environments that can be customized to meet individual needs of schools and students.

### **Associate Initiative 1: Unified Communication and Collaboration/ IP Telephony & IP Video Conferencing**

To extend and expand the in-depth usage of information and collaboration tools in teaching and learning, Unified Communication and Collaboration technology including IP telephony, IP video Conferencing and collaboration tools are needed to consolidate the infrastructure that will provide true convergence between the worlds of voice and data. Until now, these have traditionally been designed and implemented as isolated technological solutions. This initiative is associated with (and described in) Section 6A of this document, "Converged Network Infrastructure".



## **Associate Initiative 2: Learning Content Management System (LCMS)**

In order to support the educational goals and objectives for the 21<sup>st</sup> Century teaching and learning environments, DIIT has chosen to implement an LCMS application, called “Moodle”, which is an open-source web-based course management system that is customizable for creating effective online learning resources. This initiative is associated with (and described in) Section 9 of this document, under “Student Learning and Collaboration”.

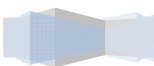
## **Associate Initiative 3: Virtual Desktop Infrastructure (VDI) Environment**

Implementing the Virtual Desktop Infrastructure in selected schools according to need and budget is essential to offer ubiquitous access to instructional applications and storage for students and teachers. VDI is a cost-effective end-user computing environment that enables teachers and students to access classroom and NYCDOE network resources from anywhere, anytime, and from any computing device securely. This initiative is associated with (and described in) Section 7 of this document, under “PC Lifecycle Management & End-User Computing”.

## **Summary**

The integration of the major initiatives described above will provide a robust platform for delivering school administrative and instructional applications to students, teachers and administrators.

Schools will benefit from the noticeable increase in quality of services and performance provided by the simplified and streamlined processes of installing, maintaining, and supporting their technology infrastructure. This will leverage the power and capacity of the NYCDOE’s existing SONET Ring fiber-optic network.



## Benefits and Impact if Not Implemented

The proposed new School Technology Infrastructure will support innovation and increase productivity in a number of ways.

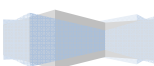
By providing a robust core and school infrastructure platform, the NYCDOE will facilitate technology-based innovation in city public schools, thus supporting instructional strategies to improve student achievement. For example, the installation of a robust core and school infrastructure platform will improve wireless access in schools in order to meet the response time needs within school buildings for students, teachers and principals who utilize Web 2.0 applications, including ARIS, and the Internet as a whole. This will enable easier infusion of technology-enhanced instructional initiatives. The following tables provide other examples of various initiatives that will be part of the new technology infrastructure plan for schools.

INITIATIVES	WHAT WILL BE DONE	WHY IT IS IMPORTANT
<b>Upgrade School Infrastructure</b>	<b>COMPUTER ROOM.</b> Relocation, consolidation and reconfiguring of infrastructure components.	It provides <b>one location</b> allowing for streamlined installations, support and maintenance.
<b>Upgrade School Infrastructure</b>	<b>NETWORK CONNECTIVITY.</b> Increasing the data “pipe” going into each school based on increased bandwidth usage.	It enables <b>more robust connectivity</b> to the NYCDOE’s network and the Internet – increasing the effectiveness of all administrative and instructional applications, such as ARIS.
<b>Unified Communication and Collaboration</b>	<b>PHONE SYSTEM.</b> Updating aging voice systems to enhance school communication and classroom safety.	It reduces the <b>cost and time</b> to modify or change PBX systems while enabling the flexibility to adopt new technologies.
<b>100% Wireless Footprint</b>	<b>WIRELESS NETWORK.</b> Improve wireless network capacity in classrooms and administrative locations in schools.	It provides <b>ubiquitous wireless access</b> within schools and the ability to manage wireless access points remotely.
<b>School Facility Infrastructure Upgrade</b>	<b>ENVIRONMENTAL CONTROLS.</b> Air-conditioning in computer room and selected classrooms with multiple computing devices. Raised-floor settings where appropriate.	It ensures <b>proper environmental control</b> for core technology infrastructure, in order to reduce the risk of hardware and connectivity failure.
<b>School Facility Infrastructure Upgrade</b>	<b>ELECTRICAL UPGRADE.</b> A comprehensive, school-wide electrical upgrade to support new enabling technologies.	<b>To upgrade aging electrical systems</b> to maintain technology infrastructure and scale to handle new technologies.

### Stakeholder User Cases benefits:

The goal is to provide a robust, secure and reliable IT infrastructure and associated services that appear seamless to all students, teachers, administrators and parents.

In 3 to 5 years, students and teachers will be able to come to any school with their own personal mobile devices, and access classroom resources. These users will be able to securely logon to the NYCDOE portal and participate in the educational and collaborative activities.



### Summary of benefits:

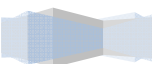
Installation of a robust school infrastructure platform will enable scalability to support new applications and will improve the NYCDOE's ability to meet current and future technology needs of schools. By providing a flexible platform, the robust core infrastructure will facilitate technology-based innovation in city schools supporting instructional strategies to improve student achievement.

In conjunction with a robust core infrastructure, a robust school infrastructure platform will also ensure the maximum availability of instructional and administrative applications. This will maximize the time students and staff spent on instruction and vital administrative tasks, and minimizes the time waiting for applications to become available, thus improving classroom and school productivity.

### Budget to Implement

Components	3-Year Plan			Total
	Year 1	Year 2	Year 3	(In mil.)
300 Schools @ \$220K per school	13.20	13.20	13.20	39.60
Infrastructure hardware and software				-
Network Infrastructure Upgrade				-
Facility Upgrade				-
Additional Wireless Coverage				-
WAN Link Upgrade				-
Redundant WAN				-
Deployment & Support	2.40	2.40	2.40	7.20
<b>Total</b>	<b>15.60</b>	<b>15.60</b>	<b>15.60</b>	<b>46.80</b>

Assumptions:	Estimate Timeline
Upgrade 60 schools per year	3-5 Years





## SECTION 5: DATA CENTER SERVICES

### *Vision*

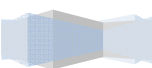
#### **Unified Storage and Enterprise Servers**

The long-term vision for the NYC Department of Education (NYCDOE) datacenter is to transform its current IT operation into a utility- and customer-oriented service model. We will tailor our solutions strategically, according to the NYCDOE's educational business needs, and set the direction for developing a standardized platform. The platform will leverage traditional infrastructure, as well as private and public cloud offerings. This platform will allow applications and infrastructure components to converge into product-service offerings, two of which are unified storage and enterprise servers. Unified storage and enterprise servers will help the organization's strategic approach to IT consolidation and building the datacenter of tomorrow.

### *Goal and Strategy to Obtain Vision*

There is a high demand for storage and servers, which are usually associated with projects for implementing new applications, especially in educational IT. Storing and sharing data on a secured online storage platform is vital to the organization's intellectual capital growth and business dynamics.

The goal of DIIT's plans for unified storage is to be able to offer storage as a service as a service to meet all education-related computing needs. We want to transform the way we use storage today, into an enterprise class service. We are moving towards consolidating all datacenter IT resources, including application and user data, into a centralized storage and server environment. A cloud-oriented environment, leveraging both an internal private cloud and external public clouds, will service the new datacenter environment. Combining unified storage with enterprise servers as part of the solution will reduce overall IT costs and provide the foundation for building a resilient datacenter. Virtualization and cloud technologies, which require storage, memory and computing power for their high-availability needs, ultimately reduce the overall physical server hardware footprint in the datacenter. With virtualization and cloud technologies forming the basis of the unified storage and enterprise server architecture, we will enable a dynamic datacenter infrastructure with high capability in terms of availability and the ability to perform "storage thin provisioning"—incrementally increasing storage capacity on-demand or as business grows. Unified storage and enterprise servers are the enabling technologies to provide an application and server virtualization solution for the enterprise, and form the foundation for a greener datacenter.



## ***Current State***

Currently, the NYCDOE datacenter(s) consists of the following:

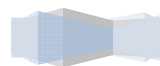
- ⊕ There are multiple file, database, and network servers using local storage for application and user data, with a large amount of unused disk space.
- ⊕ Crowded datacenter with lack of floor space for growth due to large population of physical servers.
- ⊕ Currently, there are several “storage islands” in the datacenter, each managed and supported independently.
  - Fiber Channel SAN for Production/Exchange
  - Fiber Channel SAN for Virtual Machines (Web Servers)
  - Internet-SCSI SAN is also used in few small environments, where performance is not a priority, such as labs and classrooms.
  - Network Attached Storage for LCMS
  - Direct Attached Storage via SCSI for user and application data storage

## ***Current Challenges***

The most critical problem that we currently face is running out of online storage. We often advise users to delete or move existing data from the network shares, in an effort to free-up disk space. Inadequate network data storage affects the overall end-user experience and impedes business productivity.

Islands of information are prone to creating duplicate data across the network. Centralization of these databases will reduce administrative overhead. Some file servers are only using 20% of full storage capacity while others are at full utilization. It is difficult to track usage and implement the right sized storage for each NYCDOE location, due to frequent changes in the organization. Users demand more online storage for their work data. There is some unused storage in the datacenter, but we cannot always leverage available storage due to infrastructure limitations. We simply do not have the right level of flexibility and scalability to appropriately extend the current storage environment.

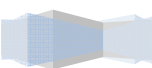
In the past, it has been a challenge for us to support software evaluation efforts for the application development teams, due to resource constraints. It takes a lot of time and energy to prepare test environments for this purpose. We are piloting the use of virtualization in a test lab environment in order to provide virtualized resources on demand in support of software evaluation initiatives. This will minimize the amount of time required to build out evaluation computing environments.



## Target State

The end-state is a reduction in the number of physical servers in the datacenter with petabytes of centrally managed storage. The reduced compute infrastructure will create a private cloud compute environment that can be leveraged by all DoE entities. Unified Storage is the foundation for a resilient datacenter, business continuity and cloud computing.

- ⊕ More storage for everyone
    - Satisfied end-users, equates to a productive workforce
  - ⊕ Centralized SAN environment
    - One large SAN for the entire NYCDOE
  - ⊕ Integrated provisioning workflow
    - Streamlined support processes and procedures
    - Utility computing
    - Employed charge back model
  - ⊕ Campus cloud-like environment
  - ⊕ Reduction in administrative costs
  - ⊕ True disaster recovery solution
  - ⊕ Increased overall service availability
- ⊕ Sustainable datacenter
  - ⊕ Instantly restore data from backup
  - ⊕ Reduced storage consumption in disk-to-disk backup using deduplication
  - ⊕ Easily generate usage statistics and prepare a budget to extend the storage capacity
  - ⊕ Efficiently utilize storage capacity effectively through “Thin Provisioning” — similar to how Google and Yahoo generously provide storage to its subscribers.



The diagram below depicts the future state of the datacenter, showing **Unified Storage** as the core component for all services and provides storage for everyone in the organization.

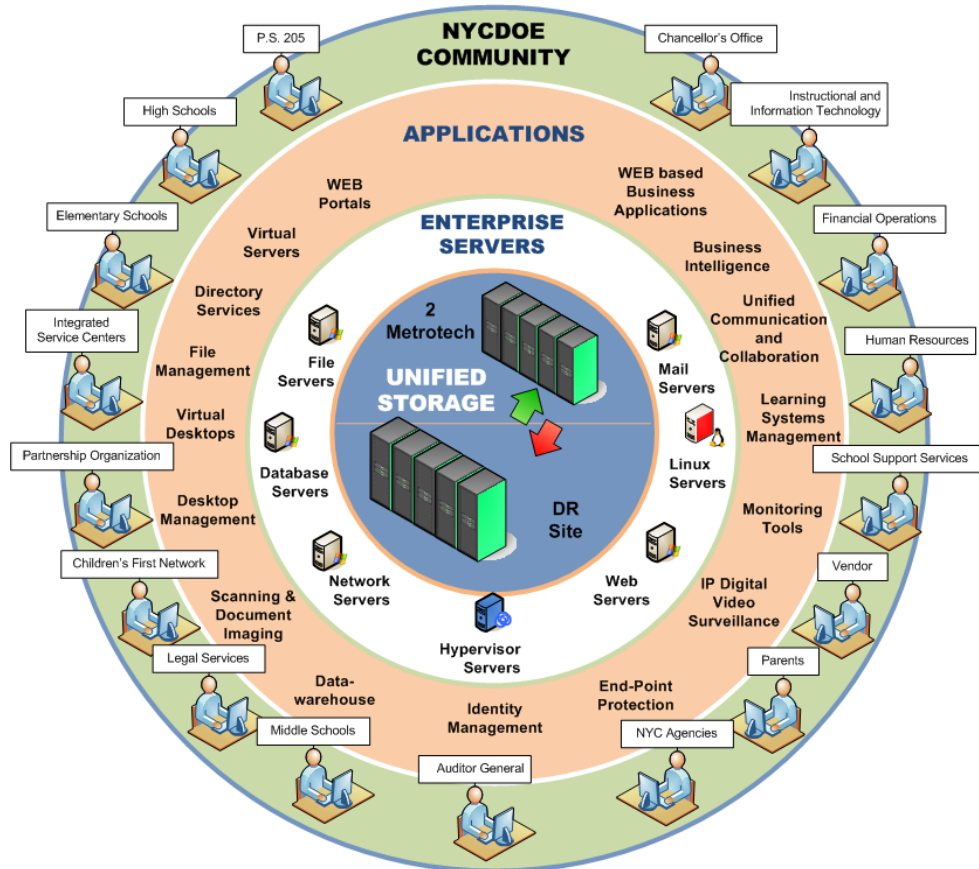


Figure 5-1: Unified Storage

## High-level Functional Requirements

- ⊕ Increase overall storage capacity
- ⊕ Provide storage as a service
- ⊕ Create private cloud compute environment
- ⊕ Enable us to leverage public compute clouds
- ⊕ Centralize storage management
- ⊕ Increase application and server availability
- ⊕ Provide enterprise class server and application virtualization
- ⊕ Efficient utilization of storage
- ⊕ Provide shared storage between core infrastructure servers
- ⊕ Reduce server hardware footprint
- ⊕ Reduce server hardware heat and energy consumption
- ⊕ Provide on-demand storage solution
- ⊕ Ability to replicate data across the SONET ring for disaster recovery
- ⊕ Easily procure and install multi-terabyte SAN-attached disk array subsystems and subdivide their capacity among several servers, in many cases running unrelated applications to achieve economy of scale in both capital expenditure and management—efficiently redeploying disk storage capacity among servers as business grows.
- ⊕ Quickly transfer or pull critical data from application to application.
- ⊕ Reduce the amount of time to backup and recovery of data
- ⊕ Provide high I/O bandwidth for data mining requirements

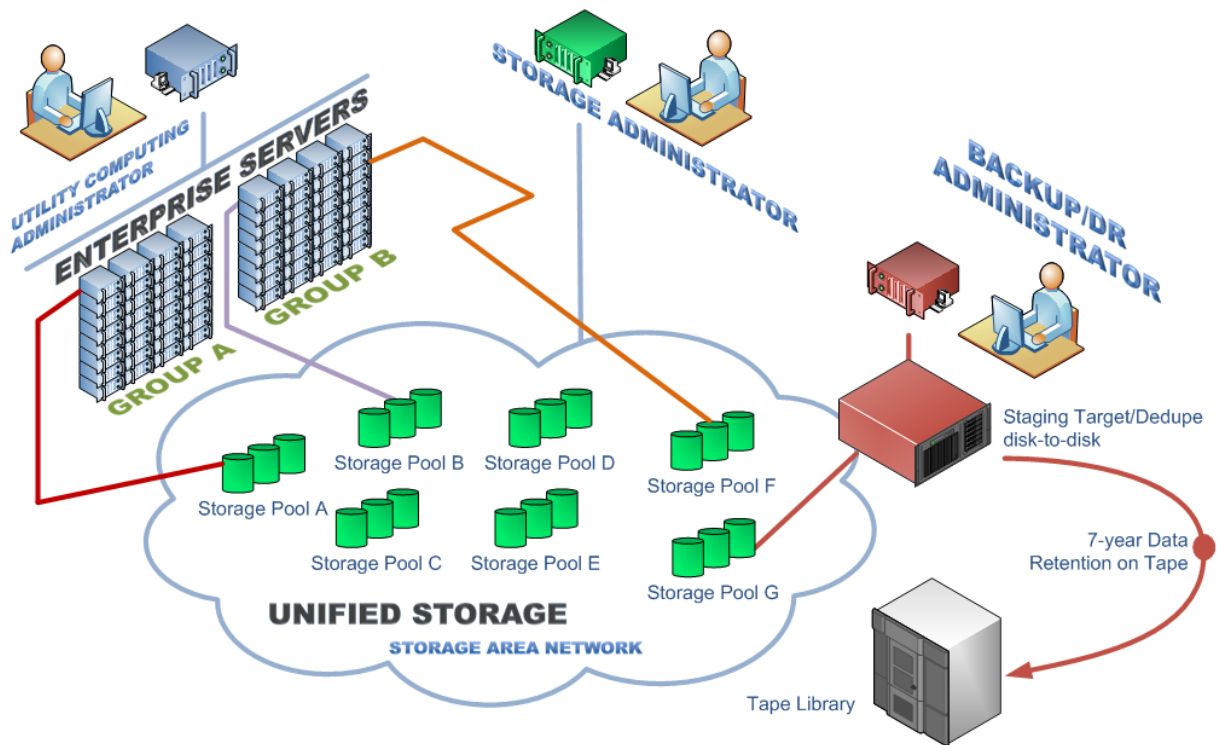


Figure 5-2: Utility Computing

## ***Recommendations and Roadmap***

The following roadmap shows the path to obtain the vision.

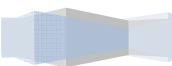
1. Embrace the vision.
2. Share the vision with the entire NYCDOE community.
3. Build a unified storage platform to meet existing and future needs.
4. Build an enterprise server infrastructure to support the applications with scalability and extensibility.
5. Implement the tools to efficiently and effectively manage the environment.
6. Develop sets of policies, processes, and procedures governing the storage and servers in the datacenter.

### **⊕ Enabling Technologies**

- Storage Area Network (SAN)
- Fiber Channel over Ethernet (FCoE)
- SAN Fabric Switches
- Internet Small Computer System Interface (iSCSI)
- Virtualization technologies
- Serial Attached SCSI (SAS)
- Serial ATA (cheap storage)
- Network Attached Storage (NAS)
- Data Deduplication technology
- Data Replication technology
- Multi-Core systems
- Blade Center systems
- Host Bus Adapters
- Common Internet File System (CIFS)
- Network File System (NFS)
- Distributed File System (DFS)

### **⊕ Support Model for New Environment**

- Build storage as a service
- Procure storage as needed
- Use of “cost-effective” storage disk arrays
- Utility-centric service offering
- Assigned team to provide storage for the enterprise
- Storage for any servers/applications
- Developers to develop SAN products
- Centralized backup and recovery



## *Stakeholder Use Cases*

### **Home Directories**

User home directories today are stored on local servers with Directly Attached Storage (DAS) and these servers are often underutilized. With Unified Storage, we can fully utilize our total storage capacity and move away from silo storages to a pooled storage model, which also consists of NAS with NFS and CIFS support. We no longer need to worry about the physical limitations of DAS and grow the storage environment dynamically, similar to how Google and Yahoo thin provision to incrementally increase their storage.

### **Virtualization in the Datacenter**

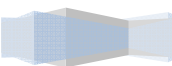
Virtualization is becoming the de facto standard for implementing services in the datacenter—from virtual servers, desktops to applications. Implementing virtualization in the enterprise requires storage for its high-availability needs. The number of guest operating systems or virtual machines hosted inside each physical virtual host depends on the three requirements, storage, CPU and memory. Increasing the number of CPU/cores, storage and memory also increases the number of virtual machines allowed in a single physical host. The more virtual machines a single physical host can handle, the less we need to purchase new servers. We can easily fork-lift the entire datacenter when virtualized to a strategically assigned disaster recovery site. Virtualization and unified storage are the foundation for datacenter resiliency.

### **Lab Environments**

One application of virtualization is the establishment of software test environments. In the past, it has been a challenge for DIIT to support software evaluation efforts for the application development teams, due to resource requirements. It takes a lot of time and energy to prepare test environments for this purpose. We are piloting the use of virtualization in a test lab environment in order to provide virtualized resources on demand in support of software evaluation initiatives. This will minimize the amount of time required to build out evaluation computing environments.

### **Storage Consolidation**

The NYCDOE consists of several storage environments where global-interesting data are stored. We can consolidate all these storage environments into the unified storage environment, where it can be managed centrally. This will ease movement of data between databases securely, and increase performance in transactional processing.



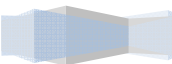
### ***Benefits and Impact if Not Implemented***

Implementing Unified Storage and using Enterprise Servers for the NYCDOE will realize several organizational goals: from server application to desktop virtualization, and including the idea of campus cloud and on-demand computing, it will transform our datacenter into a more dynamic and resilient environment. Unified Storage with Enterprise Servers is the key to a successful IT consolidation, providing the greatest storage flexibility. Additionally, by exploiting emerging market trends, DIIT will immediately realize long-term reductions in deployment and administrative costs.

If not implemented, the datacenter will continue to operate as is without the added efficiency and resiliency of unified storage. We will continue to have servers with underutilized storage and islands of information across the organization. This also prevents us from moving towards the development of a sustainable and dynamic datacenter. Without the right foundation, we will operate inefficiently, and we are unlikely to lower total cost of ownership due to ever-growing demand for storage and servers.

### ***Budget to Implement***

<b>Components</b>	<b>3-Year Plan</b>			<b>Total</b>
	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>(In mil.)</b>
Hardware	45.00	20.00	10.00	75.00
Software	10.00	10.00	10.00	30.00
Professional Services	20.00	10.00	10.00	40.00
Facilities	3.00	2.00	-	5.00
<b>Total</b>	<b>78.00</b>	<b>42.00</b>	<b>30.00</b>	<b>150.00</b>





## SECTION 6: NETWORK INFRASTRUCTURE

Network Infrastructure combines the traditional wired network and wireless network. The wired network infrastructure will provide a robust converged network infrastructure (CNI), including voice, data and digital video communications network throughout the city, to improve educational and organizational effectiveness. The next generation wireless network including a high-speed, widely deployed, highly available, scalable, secure and fully managed Next Generation Wireless (NGW) network to provide the bandwidth capacity, flexibility, mobility, and secure access to students, teachers, administrators, schools operations, schools services staff and to school visitors.

### *Converged Network Infrastructure*

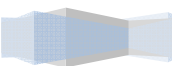
#### *Vision*

The vision of the converged network infrastructure is to meet the needs of the next generation of learners and educators in real time. The converged network infrastructure will be standardized, agile, consolidated, virtualized and will be focused on delivering learning activities, knowledge and information to anyone, anytime and anywhere. The converged network infrastructure will be closely aligned with the business needs of the organization, and will rise to meet it proactively. The NYCDOE envisions the robust converged network infrastructure needed to integrate voice, data and digital video communications network throughout the city to improve its educational and organizational effectiveness. The infrastructure that supports that network must incorporate communication to and from home, classroom, school, Instructional Learning Centers, community, state, nation, and world. To improve communications among all of its stakeholders, the NYCDOE should establish a voice, data, and to the extent possible, video network linking all sites and connecting all computers and shared peripherals to the network. Students and staff should have access to networked library systems for information resource management and retrieval. Integrating all of the networks in a school with appropriate network infrastructure, security safeguards, and network management will improve instructional communications effectiveness.

### *Goals and Strategy to Obtain Vision*

**Converged Network Infrastructure Goals:** Provide a robust converge network infrastructure to support 21<sup>st</sup> learning and teaching environment including:

- ⊕ Develop a comprehensive networking plan for communications within and among schools and sites with the goal of complete interoperability to enhance teaching and learning experiences: collaboration, creative, and individualization.



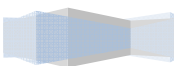
- ⊕ Enhance communications services to all sites through instructional portal, electronic mail, school websites, school calendars, video conferencing, digital media, voice mail, and access to educational research sources.
- ⊕ Increase parental involvement using the telephone, voice messaging, voice response, Internet, e-mail, and web portal services.
- ⊕ Identify and implement cost effective ways of linking existing and future telephony systems into the NYCDOE network and, possibly, the Internet.

#### **Converged Network Infrastructure Strategies:**

- ⊕ Upgrade core network infrastructure including SONET/DWDM network and ISP bandwidth to ensure adequate bandwidth for new learning and teaching environment of the 21<sup>st</sup> century.
- ⊕ Strengthen the availability, and reliability of the core network
- ⊕ Implement Traffic prioritization and ensure adequate quality of services (QOS) to support collaborating and interacting learning environment
- ⊕ Expand secure access to network resources to parents and students from anywhere, and at any time
- ⊕ Enable technology to support rich media content by integration of video and other media to support instruction links between students and outside resources, thus enabling teachers to address many different learning styles.
- ⊕ Enable indexing features in the video content management system for students and teachers to reuse these educational videos.
- ⊕ Enable multicast technology to deliver content efficiently over the WAN whenever possible.

#### ***Current State***

The current NYCDOE network consists of a SONET/DWDM core and multiple WAN technologies connecting the core to over 1600 schools within 1200 physical sites across New York City. The current core is about 84% provisioned. Currently, every school has a single WAN connection running at Frame Relay (FR), Asynchronous Transfer Mode (ATM), or Metro Ethernet (ME), with a 56 kbps dial-up link for backup. There is QoS (Quality of Service) capability on the FR and ATM connections, but not on the ME connections. The Content Delivery Network (CDN) consists mainly of Content Engines (CE) in the schools. Its main function is to cache web content retrieved from the Internet. Once the static content is cached by the school CE, subsequent requests to the same content can be delivered locally by the CE. This improves the user experience, and conserves WAN bandwidth. The total aggregated WAN bandwidth connecting to the core is approximately 6.3 gigabit / second. However, currently, the NYC DoE ISP circuits only provide approximately 28% of the total aggregated bandwidth. The current DOE core has a



server farm housing support personnel at 2MT to access the schools for troubleshooting efforts. It does not have an n-tier server farm supporting school facing applications.

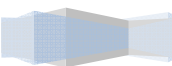
## ***Future State***

### **Creating a robust core infrastructure technologies**

In order to transport the new generation of Instructional Support and instructional applications, such as a virtual learning environment with collaboration mechanisms, including Video-Conferencing and Voice over IP, a reliable fiber-optic network infrastructure backbone implemented with the capacity of 10 Gbps needed to be upgraded and refreshed. Another wavelength of 10 Gbps capacity will be provisioned to provide the necessary bandwidth capacity and availability to accommodate the rich media applications. Deployment of technologies that utilize video as a medium will not be possible over the existing infrastructure. Convergence of voice, video and data onto a uniform IP infrastructure will be a necessity, in order to provide the demand for future services to support the instructional learning environment.

The New York City Department of Education is committed to providing a robust and scalable network infrastructure. The current infrastructure standard for 1,300 schools was created based on the strategic vision of the NYCDOE to establish a common baseline for all the NYC public schools to provide high availability, scalability and optimum performance of Internet access and administrative application to students, teachers and administrators in the schools. A common robust infrastructure will enhance the current infrastructure architecture and networking standards in the core network. The future enhancements can be summarized as follows:

- ⊕ Upgrade the bandwidth capacity of the core networking, including the SONET/DWDM network and ISP bandwidth, to ensure adequate bandwidth for the new learning and teaching environment envisioned for the 21<sup>st</sup> century.
- ⊕ Strengthen the availability and reliability of the core network.
- ⊕ Implement Traffic prioritization and ensure adequate quality of services (QoS) to support a collaborative and interactive learning environment.
- ⊕ Expand secure access to network resources to parents and students from anywhere, and at any time.
- ⊕ Implement common enhanced network services components, such as IP telephony, Content Delivery Network (CDN), and Streaming Media, which will be available to support media- rich traffic and a collaborative environment.
- ⊕ Upgrade the 2MT server farm to allow more advanced troubleshooting efforts.
- ⊕ Install Application Server Farm to enable school facing n-tier applications.



## ***Recommendations and Roadmap***

### **DWDM Infrastructure Upgrade**

The SONET/DWDM Ring Core Network Architecture is aligned with the long-term IT strategy of the New York City Department of Education. The objective of this plan is to improve the overall infrastructure enabling the NYCDOE provide enhanced services using a more efficient method. The SONET/DWDM Ring Core Network Architecture, using Dense Wavelength Division Multiplexing (DWDM) as its base infrastructure, will provide a high capacity optical network for the next ten years. The topology is geographically distributed into hubs located within the six Operational Centers, while each school feeds into the network as a spoke from each hub. Each hub site connects to the central core located at Two MetroTech, and the architecture is flexible enough to add alternate locations in the future. The hub sites will be strategically interconnected for hub redundancy. Currently, the first wavelength of SONET/DWDM Ring Core Network is approaching its capacity of OC 192 speeds, and the second wavelength with another OC 192 is needed to provide adequate bandwidth for the anticipated increase in bandwidth requirements, especially for the LCMS, VDI, and media reach applications.

### **ISP Upgrade**

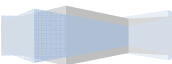
The current ISP infrastructure was built around 2MT as the primary site for Internet Access, with Staten Island and Manhattan providing additional bandwidth to the Internet.

In order to provide a truly distributed ISP facility, an equipment upgrade is needed to provide a scalable and redundant Infrastructure for each ISP node.

### **IP Network Infrastructure Upgrade**

In parallel with upgrading SONET/DWDM Ring Core Network, the existing IP core network infrastructure also needed to be upgraded. The upgrade can be summarized as being comprised of the following technologies:

- ⊕ BGP Router – provides robust redundant gigabit connections to multiple ISPs for Internet access.
- ⊕ Metro Ethernet QoS– provides Quality of Service capability on the Metro Ethernet circuits. This allows the core network to provide preferential services to the voice and video traffic.
- ⊕ Load Balancers – provides a scalable method to add proxy and filtering servers for Internet traffic without affecting any user configurations.
- ⊕ Firewall – provides protection of the DOE infrastructure from being the target of attacks originating from the Internet.
- ⊕ 10G LAN – provides a 10-fold increase in LAN bandwidth in the core network.



- ⊕ Traffic packet shaper – provides the NYCDOE with the capability of categorizing and prioritizing Internet traffic.

### **Content Delivery Network (CDN) Infrastructure Upgrade**

An upgraded content delivery network (CDN) provides high-quality, high-speed access to rich media (such as streaming audio and video) throughout a distributed network. This allows such materials to be accessed on-demand from remote locations, such as schools, that previously did not have sufficient network bandwidth to take advantage of them. This ability provides numerous opportunities to enhance the educational process, for both students and staff.

Integration of the above major initiatives will provide a robust core platform for delivering school administrative and instructional applications to students, teachers and principals. Schools will benefit from the simplified and streamlined processes of installing, maintaining, and supporting their technology infrastructure. This will leverage the power and capacity of the NYCDOE's existing SONET Ring fiber-optic network.

### **Enterprise Virtual Private Network (VPN) infrastructure**

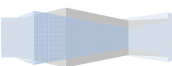
Enterprise VPN architecture should be designed, developed, and deployed to allow teachers, principals, parents to access student information from the Internet. This enterprise VPN architecture will allow students to ubiquitously access to a virtual learning environment from anywhere, anytime, and using any device. This VPN environment will also support staff in performing remote support functions in a secure format.

## ***Benefits and Impact***

- ⊕ Provide a robust converge network infrastructure which will be scalable, adaptable, and manageable to the need of data, voice, and video traffics
- ⊕ Consolidation of voice and data equipment and resource management, providing economies of scale.
- ⊕ Multiple converged communication applications across many now disparate office tools and all within a common experience.
- ⊕ Collaborative work groups and project meetings via web, video and audio conferencing – in the context of the classroom and School administration. Enhanced classroom environment and communications - parent engagement, pupil to pupil, teacher to pupil and vice versa, and administrators to other administrators.

## ***Stakeholder User Cases benefits***

A robust, secure and reliable IT infrastructure, and its related services, must appear seamless to all students, teachers, administrators and parents.



In 3 to 5 years, students and teachers will be able to come to school with their own personal mobile devices, and rely on the fact that they will be able to connect to the NYCDOE network with such devices. These users will be able to securely logon to the NYCDOE portal and participate in educational and collaborative activities.

### ***Summary of Benefits***

Installation of a robust core infrastructure platform will enable easier scalability of new applications; and it will improve the NYCDOE's ability to meet current and future technology needs of all city schools. Providing a flexible platform, a robust core infrastructure platform will facilitate technology-based innovation in city schools supporting instructional strategies to improve student achievement.

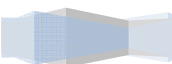
A robust core infrastructure platform will also ensure the maximum availability of instructional and administrative applications. This will increase the time students and staff spending on instruction (as opposed to administrative tasks) and, thus, improve classroom and school productivity.

### ***Budget to implement***

Here is a robust Core Infrastructure Five Year Expansion Strategy, including the following enabling technology to support 21<sup>st</sup> learning and teaching environment:

	3-Year Plan			Total
Components:	Year 1	Year 2	Year 3	(In mil.)
Unified Communications and Collaboration software & hardware for 300 schools	6.00	6.00	6.00	18.00
SONET/DWDM New Wavelength Services 10 G	-	-	0.25	0.25
Core Network Infrastructure Upgrade	10.00	-	-	10.00
<b>Total</b>	<b>16.00</b>	<b>6.00</b>	<b>6.25</b>	<b>28.25</b>

Assumptions:	Estimate Timeline
Deploy Unified Communications and Collaboration solutions to 300 schools	3-5 Years
SONET core upgrade (in the third year)	2-3 Years
Core network upgrade (in the first year)	1-5 Years



## Next Generation Wireless Network

### *Vision*

The NYCDOE envisions a high speed, widely deployed, highly available, scalable, secure and fully managed Next Generation Wireless (NGW) network. This network will provide increased radio frequency and bandwidth capacity, flexibility, mobility, and secure access to students, teachers, administrators, schools operations, schools services staff and to the school visiting community.

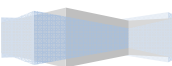
We are using the phrase “Wireless for Learning and Achievement” to emphasize the underlying mission of this initiative. “Wireless for Learning and Achievement” renews the NYCDOE’s commitment to use technology to add value to teaching and learning services. In order to implement these changes, and improve our ability to help our schools, we plan to upgrade our existing wireless infrastructure to one that will make “wireless” the platform of choice for many instructional services, and that will meet the next generation of school computing needs.

### *Goals and Strategy to Obtain Vision*

The New Generation wireless initiative will build the central backbone required to support next generation wireless computing, including a comprehensive wireless management system, which is a wireless network security system to protect the school wireless perimeter from attacks and vulnerabilities due to the inherent broadcast nature of wireless access that can create unique security issues. This architecture will also provide a reliable wireless printing solution for the classrooms to mitigate the wiring, legacy workgroup bridging, and electric power issues related to the existing printing setup in the classrooms.

The following are the main components comprising the Next Generation wireless upgrade:

- ⊕ Central wireless infrastructure for deployment, security, management and support.
- ⊕ School Instructional wireless network upgrade.
- ⊕ School services and administrative wireless network deployment.
- ⊕ School wireless network security monitoring and wireless network perimeter protection
- ⊕ School wireless printing upgrade.
- ⊕ School assets location and protection.





The diagram below provides an overview of the new wireless network topology.

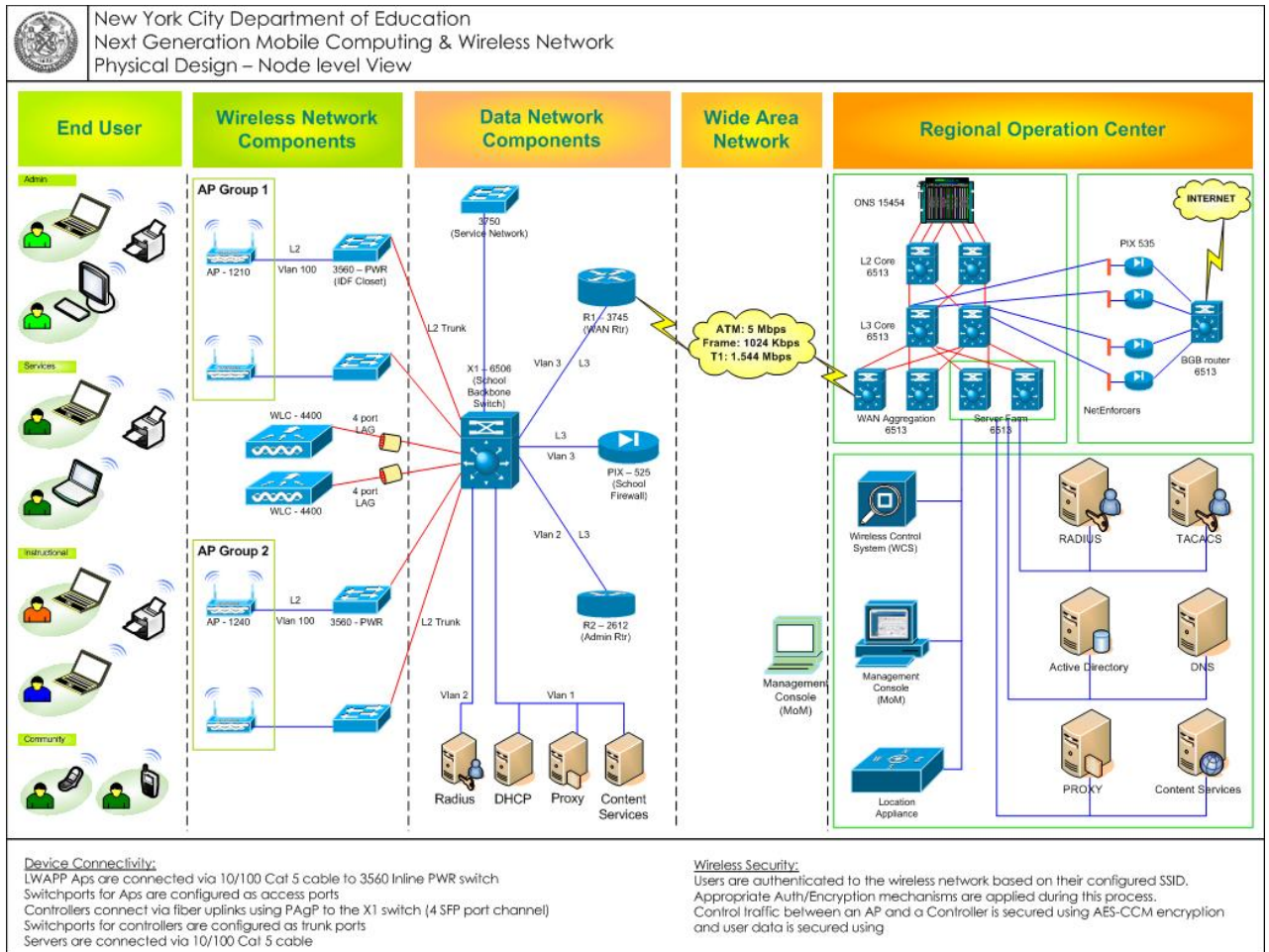


Figure 6-1: Wireless Network Topology Overview



## ***Current State***

### **Introduction**

In today's school environment, technology complements the idea that learning is something personal that cannot be mass produced, and that computers help students build the confidence, curiosity, autonomy, and skill to pave their own unique learning paths.

Why wireless laptop computing? The local area networks that bring computers alive in school buildings by providing connectivity between users and the Internet are sprouting wireless segments at an increasing rate, and for good reasons. Foremost among these are the freedom and simplicity of working without wires. In older school facilities or portable classrooms, wireless offers a quick way -- sometimes the only practical way -- to get students computing.

The Next Generation Wireless network deployment is a large-scale system-wide initiative that will enable the delivery of instructional, administrative and services applications over a high-speed, managed, and secure wireless network.

The goals of the Next Generation wireless initiative are to deploy a wireless infrastructure in existing schools to meet current and future schools instructional wireless access requirements and to address technological limitations and issues associated with the current wireless infrastructure. It will also allow control of school Radio Frequency in order to mitigate issues related to interference, noise and inadequate RF signal coverage in the classrooms caused by the constant RF environment changes induced by neighboring buildings and internal interference.

### **Today's setup and challenges:**

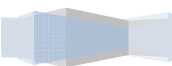
While the current wireless standard serves the NYCDOE's basic wireless connectivity needs, there are a number of challenges the environment is facing that should be addressed in the next generation wireless LAN.

#### ***Lack of capacity:***

Over 41% of schools are running with Cisco 350 802.11b only Access Points, with a bandwidth capacity of 11 Mbps and actual throughput of 7Mbps per classroom; this limits the access speed and capacity to the network, especially when wireless client population is expected to continue to rapidly increase over the near-term. 802.11b is also limited to 3 Non-overlapping channels (1, 6 and 11) and is operating in a heavily congested frequency band (2.4 GHz), making the school network susceptible to internal and external interference.

#### ***Lack of wireless network RF (Radio Frequency) management:***

Today, NYCDOE lacks the RF management platform to report on the RF environment in the schools. Coverage, interference, and wireless performance issues cannot be diagnosed



remotely. As a result there is no proactive monitoring system to reporting that a wireless AP (Access Point) is down; the help desk is relying on users' calls to report wireless connectivity outages or problems. There is no remote capability to report whether a classroom is properly covered with adequate RF signal without deploying a technician to perform a manual survey. Also, there is solution in place to track and report on client/end user performance.

#### ***Support challenges:***

Approximately 25012 (Cisco 350) access points are reaching end-of-life, and the last support date is 10/31/2008. This would affect 479 schools, introducing support challenges today, resulting from mix-and-match situations.

#### ***Lack of mobility:***

The current setup which was deployed approximately 6 years ago was not designed to support site to site mobility. Mobile users, such as coaches, nurses, and administrators, are required to maintain separate profiles for each school they visit. Roaming is available only *within* a school, *not* school-to-school.

#### ***Lack of security:***

The current NYCDOE wireless network utilizes WEP encryption to protect the data between the user's laptop and eth school AP. WEP has proven to be a weak security mechanism and is an obsolete way to secure wireless access. A WEP key can be cracked within minutes. Administrative wireless cannot be deployed or supported without stronger, more appropriate security architecture of authentication, encryption and Intrusion detection defense. A higher security platform is required to support future secure wireless computing at the NYCDOE.

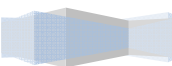
Rogue Access points are un-authorized wireless access points that are often installed by school staff unaware of the threat they represent. Rogue APs constitute a serious security exposure. Their widespread presence introduces support problems, interferes with existing wireless and wired infrastructure, and compromises the health and security of School networks. There currently is no Rogue AP detection and mitigation system in place.

#### ***Standards Compliance:***

Over the course of the last four years, the NYCDOE has worked extensively with wireless laptops, handhelds, and the clients' Vendors, to ensure clients' compatibility and compliance with NYCDOE wireless standards. The NYCDOE created a program for standards compliance certification and testing that requires vendors to submit wireless computing platforms to be tested for compatibility and interoperability with the NYCDOE network. Legacy clients in the schools do not meet all certification requirements. While the NYCDOE will continue to drive the certification program, it will also provide means to support legacy clients.

#### ***Wireless and the Expansion of Multimedia Content:***

Multi-media materials delivered over the web, and rich media streaming, are becoming increasingly popular sources of instructional content for the NYCDOE classroom over the



wireless network. In addition, with the expansion of the I-Teach-I-Learn (one-to-one computing) program, (and, assuming every 6th grader in select schools will receive a mobile device), wireless access requirements in the schools are expected to grow tremendously over the next four to five years.

### ***Wireless end user devices:***

The NYCDOE has made a significant investment in current wireless end user devices (e.g., laptops, printers, PDAs (Personal Digital Assistants), etc.). Any of future wireless infrastructure design should continue to support today's investment.

A tri-band 802.11a/b/g access point approach will help protect that investment, while providing the appropriate capacity and bandwidth needs of today's wireless laptop, which, with an IEEE 802.11a, b or g adapter, will operate with new LWAPP APs. Standards-based authentication and encryption protocols such as PEAP and advanced encryption protocols, as mandated by the IEEE's 802.11i wireless security standard will be deployed to ensure secure wireless access to the DOE network.

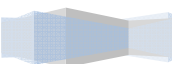
Today's school wireless LAN supports IEEE 802.11 a, b and g technology. Schools have a mixture of Intel and Apple laptops. Over 130,000 laptops are deployed system-wide. Classrooms and computer labs are the most highly concentrated area of wireless use. Wireless also serves cafeterias, auditoriums and libraries. While the wireless coverage cells design allows an average of 25 concurrent users associating with an access point within a classroom, the growing use of (bandwidth-demanding) applications directly impact the wireless access capacity. Today's laptop population accounts for over 35% of the computer base at the average school, as compared to the desktop population, and this ratio is growing as schools are buying more laptops than desktops.

## ***Target State (Future State)***

### **Introduction**

In recognition of the increased demand for wireless computing by students, teachers and administrators, plans are being implemented to enhance and upgrade the existing school wireless network. This network enhancement will provide students and teachers with an enhanced instructional technology platform for delivering educational content.

The Next Generation wireless network will provide increased high speed access capacity, flexibility, and mobility and secure wireless access. It will also incorporate the intelligence to provide control of the school Radio Frequency (RF) domain, a feature that is required to mitigate interference, noise and inadequate RF signal coverage in the classrooms. This control will help manage constant RF environment changes induced by neighboring buildings and internal interference. We recognize that the broadcast nature of wireless access results in unique security exposures. This plan will provide secure, end-to-end wireless solutions for students and administrators, and help simplify school-to-school mobility. The plan will upgrade our schools' wireless infrastructure to meet current instructional wireless access requirements, and address existing limitations and issues. The integration effort will consist of replacing 36% of existing



wireless access points, and installing an average of one to two wireless LAN controllers in each school. A centralized Wireless Network Management System will be added to the data center. This initiative will also continue to integrate schools with no current wireless capability and provide them with the new, Next Generation wireless infrastructure.

### The Future Service Oriented Wireless Network Architecture

Clearly NYCDOE is in need of a new wireless Architecture that addresses the current challenges and positions wireless network to be the “platform for learning, educating, and operating schools” in the next decade wireless digital classroom.

The NYCDOE’s vision is a comprehensive end-to-end Service Oriented Wireless Network Architecture (SOWNA) that transforms the wireless architecture (as depicted in the diagram below) into a platform that allows the schools to provide:

- ⊕ Learning services,
- ⊕ Administrative services
- ⊕ Operational services
- ⊕ Collaboration services.

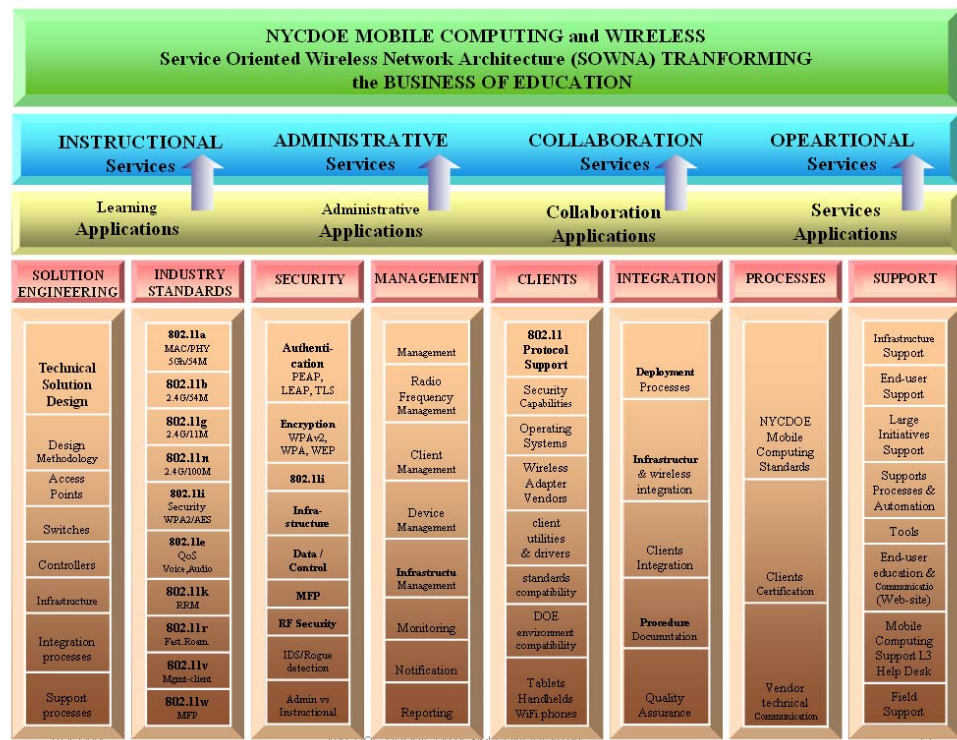


Figure 6-2: SOWNA

LWAPP, the LightWeight access point protocol is at the core of the Next Generation wireless design. Based on a proposed IETF standard, this architecture transforms how a wireless LAN is designed and operated. A traditional standalone (autonomous) wireless access point performs all RF association, MAC layer functions, network protocol conversion, and authentication and quality of service. In the Lightweight architecture, access points are provisioned, controlled and managed by a single WLAN controller that performs several functions, including dynamic radio channel and transmission power assignment, to help avoid Radio Frequency (RF) interference and optimize coverage.

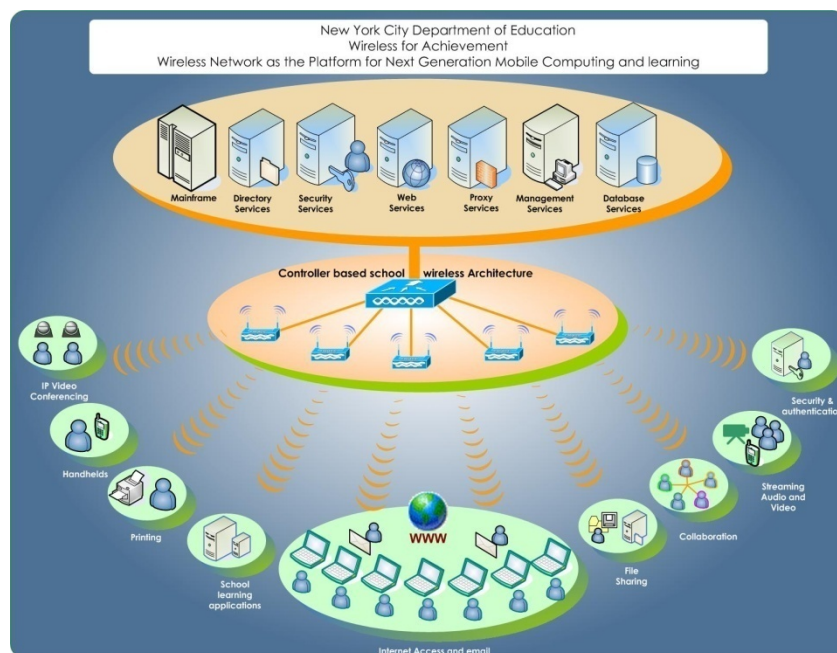
## Wireless as the platform for learning and collaboration

The NYCDOE believes that with the right architecture, technology and processes wireless will become ‘the platform’.

Built on a Service Oriented Wireless Network Architecture (SOWNA) framework, this next generation wireless network will provide learning services, mobility services, security services, and streaming audio/video and collaboration services (see diagram below). As currently planned, this activity is focused on the instructional, administrative and operational services network.

This new infrastructure will build on the investment already made in the existing infrastructure; functionally, the new infrastructure will be a great improvement over the existing one. This next generation design will make the wireless network the standard platform for computing at NYCDOE schools. As depicted by Figure 1.a, the wireless network will support Internet access, several learning applications and collaboration tools. By doing so, wireless connectivity will become ubiquitous and reliable, yet transparent to the schools. It will become less of a disruption, and more an actual tool for teaching and learning that will benefit New York City children.

**Figure 6-3: Wireless will become the platform for learning and collaboration.**



## Recommendations and Roadmap

### Deployment plan:

NYCDOE will continue to deploy wireless in these schools to close the connectivity gap using the next generation standard. Wireless should be made available to all school communities. Currently, 479 schools have wireless installed for approximately 5 years, using a legacy platform that has served the schools with basic wireless connectivity, but which has been outgrown by the rising demand on wireless and is facing equipment end-of-life cycle and increasing support issues. The remaining 625 are using newer access points platforms and provide larger wireless access capacity, but are lacking the management and central control platforms. This environment provides no visibility into school RF environment and makes it practically impossible to remotely diagnose, analyze and mitigate school RF issues related to outside interference, noise, RF channels overlap, coverage holes and rogue access points; a technician needs to be on site. Support of these schools relies heavily on the deployment of field engineers with site survey and RF analysis tools, which increases the overall total cost of ownership (TCO); this limitation also applies to schools with the legacy platforms.


	Cisco 1210	Cisco 350	Summary Chart Schools AP distribution (1200+ buildings)		
AP #	42750	23756			
Schools	574	454			
802.11	a,b,g	b			
Bandwidth	54 Mbps*2	11 Mbps			
Channels	3(g) 8(a)	3(b)			
Percentage of Schools	48%	38 %	Total Number of Buildings	Total Number of Schools	Total Number of APs
Percentage of AP	64%	36%	1200+ (Estimated)	1431(including co-located)	66506

Figure 6-4: Analysis Overview

## Enabling Technologies

### Wireless Technology trends:

Trends in wireless communications today are far-reaching and accelerating at high speeds. Today, wireless computers encompass: wireless Internet, WANs, and LANs; wireless keyboards and mice pagers and PDAs; and wireless printers, scanners, cameras, and hubs. These are deployed across all industries, and have become tools integral to our daily lives. Growing trends also include voice convergence and the intersection of the indoor wireless LAN network with the outside cellular network. So-called “dual-mode” phones that function in both networks are being developed now.



Wireless will continue to provide increased flexibility, and allow workplace models that are too costly for the wired side to emerge. Wired connections will be run only as necessary for specific applications with heavy demands on high bandwidth and real-time media applications. While the wired connection will continue to provide higher bandwidth, many applications' wireless speeds will be sufficient to address most typical user's needs. The bottleneck will not be the user's LAN or WLAN connection to the local network, but the speeds provided by the upstream WAN/ internet providers.

Wireless LAN is also rapidly evolving, both as a technology and in its merging with adjacent technologies. Several 802.11 standards are surfacing in a number of areas, including: Security, Quality of Service, High Speed, 802.11n, Network Management, Fast Roaming, Ease of Use, Deployment Flexibility, and many other areas. Recent 802.11 standards, 802.11i and 802.11e, addressed the most urgent needs for better security and quality of service, respectively. However, the next wave of standards will improve performance (802.11n and 802.11r), security (802.11w), manageability (802.11k and 802.11v), ease of use (802.11u), deployment flexibility (802.11s, 802.11y, and 802.11p) and testing and performance prediction (802.11t). In short, future 802.11 standards will help wireless local area networks (WLANs) behave more like wired LANs.

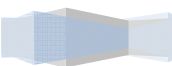
The industry expects the 802.11n to gain ground next to currently well established 802.11a/b/g standards. This 802.11n version is designed to transmit and receive data using multiple wireless antennas simultaneously. Current technologies, the 802.11b/g standards, use the 2.4GHz band, which is affected by interference from cordless phones, microwave ovens and other wireless devices. The 802.11a standard uses the 5GHz band, which has less interference. The benefit of the 802.11a devices is that they are less susceptible to interference by the other products using the 2.4GHz spectrum. MIMO (multiple input/output) doubles the spectral efficiency of the current WLANs. This means that similar technologies can coordinate multiple simultaneous radio signals, which boost raw WLAN throughput to 100Mbps. 802.11n has just started to ship to end-users. This technology is advertised to offer upward of 150 Mbps performance, exceeding the wired Fast Ethernet (100 Mbps)

But there are challenges facing 802.11n: to date, the products shipping are 802.11n Draft 2.0 technology -- the protocol is not a standard yet, as agreement on a final standard has not been reached. Additionally, and for large scale rollouts of 802.11n, the wireless enterprise must be prepared for forklift upgrades of the backend infrastructure which may prove costly.

On the client side, and for the past five years, all notebook and most desktop computers have been shipping with embedded WLAN technology. While many desktops will be wired, by 2011, notebook shipments will exceed desktop shipments in the enterprise.

#### Professional Development (Including Pedagogical and Technology Need)

The need for coordinating wireless deployment with adequate professional development is apparent when the technology is viewed in the context of instructional applications. Few technologies have a more immediate impact on the way teachers teach and children learn.



Studies have been conducted to assess the usage patterns and plans for wireless in the education vertical market. The focus is on wireless services for both wireless voice and mobile data and the spending on wireless equipment within this vertical market. Spending on wireless services is projected to nearly match spending on wired networking services by 2011. This is significant, as wireless spending in the majority of education organizations is watched very closely.

Laptops are heavily used during lessons in order to give students a more interactive approach, and to have more control over their own learning. The use of wireless network laptops means that the lesson could move with the changes in the children's location, and enhance their learning. It also facilitates the advances in technology without their being restricted to computer labs.

The wireless laptops have allowed the development of using on-line assessment to make the lessons more interactive. The impact on students demonstrated that the use of wireless laptops in many instances leads to an effective learning environment. Students are actively engaged in their learning tasks.

The use of wireless laptops in many instances has allowed assessment to be part of the student's learning activity. Online assessment removes the reliance on paper-based testing, and allows a variety of responses within the same assessment task. The storage of assessment results can become more efficient, and therefore their manipulation and analysis are made much easier. Teachers can become, not tied to assessment, but analysts using conveniently collected data to inform planning. The red pen is no longer the only tool of assessment.

## ***Benefits and Impact if Not Implemented***

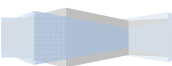
### **Architecture features benefits:**

The WLAN Light Weight Architecture provides several features and benefits that remedy today's wireless LAN issues. It provides:

- ⊕ Dynamic channel and power assignment to access point to adjust antenna transmission power to avoid Radio Frequency (RF) interference, improve performance, and optimize coverage areas;
- ⊕ Auto channel change when extreme, same channel interference is detected;
- ⊕ Automated power adjustment to compensate for offline access points;
- ⊕ Client load balancing to prevent a particular access point from an overload condition while other APs remain idle;
- ⊕ Comprehensive, centralized management options;
- ⊕ Guest access for school community users and visitors; and
- ⊕ Rogue access point detection to protect students.

### **Impact If Not Implemented:**

The current legacy wireless system that serves schools with basic wireless connectivity has not been able to keep up with the rising demand for wireless. It is also facing equipment end of life



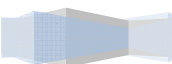


cycle and an increasing number of support issues. It lacks vital management and central control platforms and provides no visibility into school RF (Radio Frequency) environment, making it extremely difficult to remotely diagnose, analyze and mitigate school RF issues related to outside interference, or noise. This result in an increasing problem with TCO Rogue (unauthorized) access points that are being installed in the schools. With no centralized tools to detect them and block them, these rogue devices are posing a security threat. If future plans for wireless are not implemented, all these problems will continue to grow.

### ***Budget to Implement***

	3-Year Plan			Total
Components:	Year 1	Year 2	Year 3	(In mil.)
Wireless controllers and access points for 300 schools	7.00	7.00	7.00	21.00
Deployment	1.00	1.00	1.00	3.00
<b>Total</b>	<b>8.00</b>	<b>8.00</b>	<b>8.00</b>	<b>24.00</b>

Assumptions:	Estimate Timeline
Deploy Next Generation wireless solution to 400 schools	3-5 Years



## SECTION 7: PC LIFECYCLE MANAGEMENT AND END-USER COMPUTING

### *Vision*

#### **PC Lifecycle Management Program**

The vision of end-User computing described here is to develop a program where compute becomes part of the utility service offerings. This program, which consists of several technologies and business processes, will create efficiencies between the areas of supporting the NYCDOE's computing environment and the financial management. The idea here is to reduce the overall costs in compute purchases and support. The program is also known as PC Lifecycle Management (PCLM). PCLM is the practice of managing end-user systems from purchase to retirement<sup>1</sup>.

We all know that technology keeps on changing, and so do user needs. The DOE has acquired and placed many technologies in schools and administrative facilities. Studies made by the Robert Francis group show that the most cost effective refresh cycle for Personal Computers is 3 years. PCs are likely to become obsolete after three years. It costs the DOE more to support antiquated hardware after three years than it would to upgrade to newer equipment. As shown in the Forester Research report, the initial purchase price of a PC is only a small portion of the total cost of ownership (between 10 and 20 percent). This is far outweighed by administrative support and disposal costs. Delaying a refresh plan can significantly increase support costs.

#### **Eighty percent the costs goes to the following areas<sup>2</sup>:**

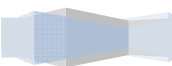
- |                    |                |
|--------------------|----------------|
| ⊕ Deployment       | ⊕ Disposal     |
| ⊕ Re-imaging       | ⊕ Image        |
| ⊕ Helpdesk         | ⊕ maintenance  |
| ⊕ Asset Management | ⊕ BIOS updates |
| ⊕ Downtime         | ⊕ Security     |

Developing this program will support several key initiatives, including the placement of various technologies in classrooms and common areas—from laptops to integrated whiteboards—for the 21<sup>st</sup> century schools by packaging solutions. The “key benefit” when implemented is the ability to streamline the process, from asset acquisition to disposition, allowing the DOE to keep our school children and the governing bodies in education well up-to-date with technology.

---

<sup>1</sup> Source: Attachmate

<sup>2</sup> Source: Forester Research



### Other Key Benefits include:

- ⊕ Reduction in energy consumption.
- ⊕ An inventory of all computing assets.
- ⊕ Secured and managed end-points.
- ⊕ Reduction in software licensing costs.
- ⊕ Enhanced end-user experience.
- ⊕ Ensure the machines are properly configured and with the right NYCDOE system images.
- ⊕ Provides notification on assets that have failed to report in x number of days.
- ⊕ Manage PC refresh cycles to their lowest cost of use.
- ⊕ Centrally deploy OS patches on-time.
- ⊕ Increased security.
- ⊕ Perform trend analysis.
- ⊕ Generate reports on-demand.
- ⊕ Enables the organization to invest wisely when it is time to purchase new machines.
- ⊕ Provides asset visibility across the enterprise: know exactly where the assets are located on the network.
- ⊕ Prevent us from paying for licenses installed on retired computers.



Figure 7-1: PC Lifecycle Management Process

## End-User Computing for Schools and Administrative Facilities

Introducing various technologies in classrooms promotes the concept of Digital Citizenship<sup>3</sup>, where educators and parents understand what students should need to know about, how and where to use it appropriately. Although most children are comfortable with technology, they often are misguided. Digital Citizenship provides the learning and awareness for teachers, students and parents in an ever growing digital world. Building the platform where technologies are integrated and purposely designed to help kids learn and a learning environment with full of excitement: challenging the young minds of the people of tomorrow.

### The vision comprises of the following components.

- ⊕ Digital whiteboards for interactive teaching, learning and collaboration.
- ⊕ Video conferencing for interactive distance teaching, learning and collaboration.
- ⊕ Virtual desktops for classroom labs, training centers and disaster recovery site.
- ⊕ Mobile computing for boundless collaboration.
- ⊕ 21<sup>st</sup> century skill development programs.
- ⊕ Technologies tailored to help students learn and educators teach effectively.

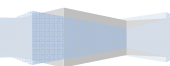
As the classroom and office boundaries are extended beyond its walls, the greater the need for mobile computing for boundless collaboration. This will enable students and educators to pursue discussions and ubiquitous access to informative resources in common areas, across corridors, libraries and student labs.

Our vision is to allow wired, wireless and remote access from all platforms to anywhere at any time for students, teachers and support staff alike.

The classroom of tomorrow will provide 24/7 access to school learning resources available on the network and not bound to the physical desktop, cables and operating system limitations. We foresee seamless access to classroom resources from school hallways to the kitchen counter at home.

---

<sup>3</sup> Source: <http://digitalcitizenship.net>, Digital Citizenship.



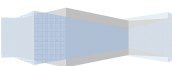
## Goals and Objectives to Obtain Vision

### PC Lifecycle Management Program

- ⊕ Implement an enterprise Desktop Management solution for the instructional and administrative environments, providing the following functionalities:
  - Power Management
  - Patch Management
  - Application Management
  - Configuration Management
  - Asset Management
  - Remote Management
- ⊕ Extend the FAMIS eCatalog's functionality to integrate with Desktop Management's back-end database for asset tracking and reporting. This will provide visibility to new and existing assets and help prepare a budget for replacing antiquated systems or purchase additional software licenses.
  - Collaborate with critical NYCDOE stakeholders for the development of the requirements document.
  - Employ business analyst(s), asset acquisition officer(s), product specialist(s), and project manager(s) to perform evaluation, develop processes and procedures around PC lifecycle management as well as coordination with stakeholders throughout the organization.
  - Employ application developer(s) or utilize existing in-house developers to create a new business function(s) or feature(s) for managing assets, including software licenses, through the NYCDOE financial application.
  - Develop a right-sizing tool for the asset acquisition process.
  - Develop disposition workflows with notifications on assets that are about to expire.
  - Develop WEB services API for asset inventory synchronization between NYCDOE and vendor systems. This will ensure our data correlates with the manufacturer's product systems information, including warranty coverage.
  - The new application should also provide leasing options for short-term contractual projects or projects with budgetary constraints, since future OS builds will no longer be bound to bare-metal machines. Providing the best option during the economic downturn.
- ⊕ Develop a recycling program for the disposal of antiquated systems. This step should be part of a scheduled process, and take action as soon as after the asset expires. The recycling program also includes the destruction of disk platters or methods to securely erase confidential data based on the data clearing standards implemented by the **Department of Defense**—DoD 5520.22-M<sup>4</sup>.
- ⊕ Package and publish computing solutions for schools and central administrative community.

---

<sup>4</sup> Source: <http://www.usaid.gov/policy/ads/500/d522022m.pdf>, United States Department of Defense.



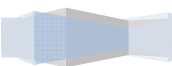
## End-User Computing

Our goal is to incorporate 21<sup>st</sup> century technologies in classrooms and administrative offices to support teaching and enhance the learning experience for students and educators.

- ⊕ Enhance the learning experience in classrooms through online collaboration for teachers and students.
- ⊕ Deploy software applications on demand and removed when no longer needed with minimum effort.
- ⊕ Implement software metering tool(s) to efficiently manage software licenses and purchases.
- ⊕ Equip and train students and educators with the skills required in today's economies.
- ⊕ Implement resilient wireless and wired infrastructures.
- ⊕ Provide virtualized desktops with access from anywhere.
- ⊕ Create a storage environment where students and educators can reliably store their work data.
- ⊕ Provide centralized support to students and educators by managing their end-user platforms remotely as much as possible.
- ⊕ Provide seamless access for educators and students from the common areas to their living room at home.

## Our Strategies:

- ⊕ Implement and deploy collaboration software tools to support centralized storage, VPN for remote access, end-user device management, thin-clients with Virtual Desktops.
- ⊕ Develop processes and procedures governing the Virtual Desktop environment for ease of management and application deployment, including platform standardization.
- ⊕ Optimize WAN bandwidth utilization and provide redundancy in WAN services for “anytime at anywhere” access around the clock.
- ⊕ Deploy secure remote access solution for allowing trusted users to their resources, while mitigating attacks.
- ⊕ Employ fulltime support staff with specialized skills to manage and support the implemented technologies in schools and administrative facilities, as well as to effectively increase the overall quality of services provided by DIIT.
- ⊕ Implement enabling technologies to support rich media content and delivery.



## ***Current State***

We have islands of underutilized storage and no place for any students to centrally archive their academic achievements, which potentially could be part of history and become leaders of tomorrow. We also have an ever growing need for storage in the central administrative environment. A huge percentage of technologies implemented in schools and areas in the central administrative offices have way passed the recommended refresh cycle of three years. DIIT is currently supporting computers that are no longer covered by the manufacturer's warranty. Without implementing PCLM, we will continue operating inefficiently and expensively due to the lack of asset visibility and manageability.

Most of the workstations in our schools are unmanaged. These workstations are vulnerable to malicious software and viruses due to the lack of Operating System patches with improperly configured antivirus software. An unhealthy computer affects the overall user experience, which then leads to loss in productivity. Malicious software and virus directly affects security and system performance. Improperly configured systems also affect the environment. The schools are the prime target for hosting explicit materials and distribution of unsolicited emails.

Our end-user support structure is decentralized. Today, we have individualized groups of technicians (Borough Support Technicians, Field Services Unit and School Technicians), supporting the instructional and administrative communities. These groups are using myriad of technologies that have evolved over the years and unable to adapt to the large number of end-point devices. Some schools are not as fortunate as others to have on-site support. We have various labs in schools where applications and operating system builds are unlikely to be the same due to disparity and lack of governance.

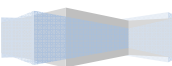
## ***Future State***

Every public school in NYC will have the opportunity to learn and use 21<sup>st</sup> century technologies in classrooms, hallways and common areas. Equally placing new technologies in classrooms creates a potential balance between poor and excellent performing schools of today. Technology is a tool, to encourage learning, enhance teaching, and help reduce the achievement gap in NYC. Why should only the top performing schools receive the best of what technology has to offer? Technology motivates children to learn in ways which they understand.

The placement of technology applies to all central administrative facilities as well. Central users can access network resources from anywhere and at any time over the 100% wireless network<sup>5</sup>. Every NYCDOE conference rooms will have a digital whiteboard, in an effort to enhance collaboration and reduce cost by eliminating the need for dry-erase markers and accessories.

---

<sup>5</sup> Refer to section 6, Network Infrastructure.



## **Virtual Desktops**

Provide a dynamic computing environment, where Operating Systems are no longer bound to its physical hardware. Using thin-client systems with Virtual Desktops is the future end-state for all end-users computing, especially in today's economies. Thin-client devices are way cheaper than its overly powered relative that is much costly to maintain. A good use case for thin-client devices are users that only require basic functionalities, such as using Word for composing a document, creating tables in a spreadsheet, using email for collaboration or just simply browsing the Internet.

## **Unified Storage<sup>6</sup>**

Implement shared storage that is accessible by all schools with the capacity to grow and expand according to the needs of our users. Create a storage environment that is replicable, agile and accessible to all. Students will have the ability to securely archive their academic accomplishments as well as for storing journals, homework, and rich content materials such as e-portfolios and videos. More storage for everyone is the future end state and with room for growth.

Virtual desktop images are stored on a highly accessible storage environment that is accessible anywhere at any time from common areas in schools to the kitchen counter at home.

## **Remote Access<sup>7</sup>**

Extend the Virtual Private Network (VPN) and Access Gateway infrastructure to the instructional community for remote access. This will enable students and educators access to classroom resources remotely from anywhere at any time.

## **Sustainable Environment**

Implementing PCLM with power management capabilities will significantly reduce power consumption, which in return creates a greener computing environment for the schools of tomorrow.

## **Portable Computers**

Wireless is becoming the platform for learning and collaboration. Students will have the ability to access classroom resources from the palm of their hand.

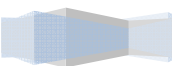
## **Digital Whiteboards**

Teachers and students will have the ability to interactively collaborate with each other during class without chalk dusts and sweaty hands due to excessive writing on trying to copy the written lecture on the board. Digital whiteboards enhances the teaching and learning experience by digitally capturing the lecture that was taught during class. The items on the

---

<sup>6</sup> Refer to section 5, Data Center Services.

<sup>7</sup> Refer to section 6, Network Infrastructure.





digital whiteboard can be emailed to students at the end of the lecture. The lecture can be uploaded to a Learning Content Management System (LCMS) for future reference and information sharing.

### **Efficient Workstations**

New workstations with efficient power supply with WAKE-ON-LAN feature can be managed through the Desktop Management console. Workstations can be turned on or off on-demand at anytime. This enables us to efficiently manage the desktops in schools and apply patches or deploy the latest version of Office without manual interventions, especially during the summer months when schools are closed. We will continue using high-powered workstations with efficient power supply for resource intensive applications such as Computer-Aided Design (CAD) and Video Editing software programs.

### **Video Conferencing**

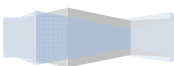
Scientists from around the world can now participate in classrooms, where students can ask questions in real-time and take the learning experience to the 21<sup>st</sup> century. Students with disability will have the opportunity to participate from home or instantly replay previous lectures. Want to know how the Large Hadron Collider works? Simply dial the CERN hotline.

### **Speech Recognition & Text-to-Speech Software/Hardware Solutions**

With a complete set of tools for students with hearing, speech or visual disability, speech recognition & text-to-speech software can help bridge the learning gap. Students with such unfortunate disability can now participate in classroom discussions using these modern tools. From Braille keyboard, speech recognition and text-to-speech with digital text magnification software allows students with such unfortunate disability to compose email messages or write a report instantly.

### **Career and Technical Training (Professional Development)**

Faculty, staff and students have the incentive to prepare their skills for the 21<sup>st</sup> century through online “self-paced” learning resources.



## ***Recommendations and Roadmap***

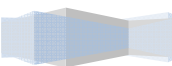
- ⊕ Embrace the vision.
- ⊕ Implement PCLM and its practices to efficiently and effectively manage our compute assets.
- ⊕ Implement an enterprise Desktop Management solution.
- ⊕ Develop processes and procedures governing the acquisition of new assets and deployment.
- ⊕ Implement Unified Storage.
- ⊕ Develop a recycling program for properly disposing of obsolete systems.
- ⊕ Develop a program where all schools equally receive technologies in classrooms.
- ⊕ Develop a program for professional development to help educators learn, understand and support the technologies in their classrooms.
- ⊕ Implement Virtual Desktops with Thin-Client devices.
- ⊕ Update the DIIT model school with all the technologies implemented in and around the classroom.

Providing access to the latest collaboration and work environment will assure our faculty, staff and students are well trained with today's relevant technologies.

## ***Benefits and Impact if Not Implemented***

The benefits of implementing PCLM in conjunction with End-User computing for the 21<sup>st</sup> century are:

- ⊕ Reduction in energy consumption.
- ⊕ An inventory of all computing assets.
- ⊕ Secured and managed end-points.
- ⊕ Reduction in software licensing costs.
- ⊕ Enhanced end-user experience.
- ⊕ Ensure the machines are properly configured and with the right NYCDOE system images.
- ⊕ Provides notification on assets that have failed to report in x number of days.
- ⊕ Manage PC refresh cycles to their lowest cost of use.
- ⊕ Help reduce the achievement gap through equality for all schools, regardless of the overall academic performance.
- ⊕ Centrally deploy OS patches on-time.
- ⊕ Increased security.
- ⊕ Perform trend analysis.
- ⊕ Generate reports on-demand.
- ⊕ Enables the organization to invest wisely when it is time to purchase new machines.
- ⊕ Provides asset visibility across the enterprise: know exactly where the assets are located on the network.
- ⊕ Prevent us from paying for licenses installed on retired computers.
- ⊕ Promotes Digital Citizenship
- ⊕ Enhance teaching and learning using the latest technology



- ⊕ Computers and storage for everyone.

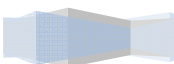
Supporting innovation and broadening the boundary of the learning environment by providing access beyond the limits of the classroom schedule. Enable students to interact and provide a global classroom which allows our teachers and administrators to concentrate on teaching and not managing desktop and access issues.

If not implemented, the schools will continue to be unmanaged and impede the process for taking the classrooms to the 21<sup>st</sup> century. This also prevents us from moving towards the development of a sustainable computing environment. Without the right foundation, we will continue to operate inefficiently, and we are unlikely to lower total cost of ownership due to ever growing demand for storage and compute. Governing the PCLM process from asset acquisition to retirement is the key to ensure efficiency, lowering our TCO over time.

### ***Budget to Implement***

	3-Year Plan			Total
Components:	Year 1	Year 2	Year 3	(In mil.)
User devices in 600 schools for 500K students @ \$500 per device	50.00	50.00	50.00	150.00
Software and security (PC-lifecycle management Tools)	6.00			6.00
Faculty and Staff PC for 75K users @ \$600 per PC	9.00	9.00	9.00	27.00
Instructional technology for 600 schools, 5 per school (e.g. digital whiteboards)	6.00	6.00	6.00	18.00
Deployment	4.00	4.00	4.00	12.00
Infrastructure Hardware	1.00			1.00
<b>Total</b>	<b>76.00</b>	<b>69.00</b>	<b>69.00</b>	<b>214.00</b>

Assumptions:	Estimate Timeline
Deploy user devices to 600 schools with 1:2 PC to student ratio	3-5 Years
Deploy user devices to 120 schools per year	



## SECTION 8: INFORMATION SECURITY AND IDENTITY

### ***Vision***

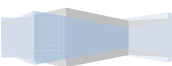
The NYCDOE's Information Security vision is of an environment in which the right people within the greater NYCDOE community have the right access to the right data, when and where they need it.

### ***Goal and Strategy to Obtain Vision***

This vision may seem somewhat unusual for a security organization. Where is the traditional cry of alarm over viruses? Spyware? Hackers? Too often, the focus of security is to act as a technology “cop,” playing whack-a-mole with specific technical threats, with the end result of “protecting” information by preventing access to it. This model is counterproductive, and runs contrary to the very purpose of information technology, which is to facilitate the creation of value from information. The NYCDOE's information security strategy was conceived with this in mind, and its focus is on providing users with the greatest possible access to the information they need without placing that information at excessive risk. Are viruses still a problem? Of course they are, and they must still be fought off. But eliminating a virus infection does not, in and of itself, contribute positively to achieving the NYCDOE's vision for information security, and therefore is not the primary focus of this strategy.

### ***Current State***

The traditional model for information security is that of the fortress: a highly secured perimeter into which users must be allowed in order to access data. This is exemplified at the NYCDOE by the physical separation of network access between classrooms and administrative offices. This model is adequate if all data use takes place in administrative offices, but once data needs to be accessed from locations that are less secure, the model falls short. This limits current access to such data to a relatively small number of individual and often bases such access more on work location than on actual need. A similar situation arises when there is a need to access data from outside of the NYCDOE's infrastructure; a virtual door in the perimeter is opened, through which basic system and data access is possible. However, setting up this virtual entrance is complicated and cannot be reasonably sustained for more than a handful of administrative users. It is certainly not a practical option for students, teachers, or parents. The result, again, is that access to data is limited to a very small number of individuals, and often not those best able to further the NYCDOE's instructional mission.



When looking at the applications and data themselves, things play out rather differently. Because security is controlled so tightly at the physical level, applications themselves have been developed with weaker built-in protections, relying instead on the fact that they could only be accessed from locations that were secure in and of themselves. This causes a serious problem when access needs to be expanded beyond the secure perimeter. Like a balloon squeezed at one end, application-level protections must be increased to compensate for weakened physical security. In most cases, the current application security is simply not strong enough to support the desired expansion of physical access.

All this is not to say that no progress has been made. As the NYCDOE began rolling out its Accountability initiative, a parallel effort was undertaken to improve the NYCDOE's information security infrastructure. This effort resulted in a significant improvement of the NYCDOE's security capabilities, particularly in the area of vulnerability management. These improvements allowed the NYCDOE to begin opening the door to sensitive data. However, to achieve the NYCDOE's ultimate goals of widespread data access, additional work is required.

### ***Target State (Future State)***

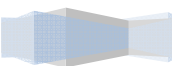
The NYCDOE's information security strategy is motivated by two primary drivers common both to the NYCDOE and to the K-12 education industry at large. These are the desire to enable data-driven instruction and accountability at the school level and the increasing need for both students and staff to access data and applications regardless of whether they are in a classroom, in a central office, or at home.

#### **Data-Driven Decision-Making**

One of the largest trends in K-12 education today is the increasing use of data by staff at all levels to make a wide range of instructional decisions and to hold schools accountable for results. The NYCDOE has embraced this strategy whole-heartedly with the Children First Accountability initiative and the first data-driven decision-making tool, ARIS, which made unprecedented amounts of student data available to school staff. ARIS, however, is only the beginning. Many features planned for the future include driving data access even further into the schools, whether by deploying school-based student systems (e.g., ARIS Local), by the expansion of periodic student assessment programs, or with the ever-increasing number of commercial third-party student data systems available to schools. Given the NYCDOE's commitment to data-driven decision making at all levels, it is clear that data can no longer be "locked up" for use by the privileged few; it must be made available when and where it's needed, without compromising security.

#### **Ubiquitous Data Access**

One of the NYCDOE's most successful recent applications is the much lauded and award-winning FitnessGram, which allows physical education teachers to track fitness information for the students they teach. FitnessGram is so successful in part because it places relevant information about students in the hands of teachers when and where they can best use it – in the teaching environment. This is possible in the current security environment because the data presented by FitnessGram is not considered sensitive or confidential. It doesn't take a major leap to realize



the value that real-time access to student academic data could provide to a classroom teacher. However, because academic data is highly confidential and legally protected, it requires a greater level of protection. At the other end of the data access spectrum are students themselves, who frequently use school-based systems to do anything from taking a test to saving a homework document. Again, it is not hard to see the value of allowing students to access these systems from home – presumably where are located when they do their homework and thus where such access would be most valuable.

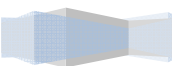
### **The Evolving Risk Landscape**

As the uses of technology in schools have evolved, so too have the associated risks. The value of making data available to the right people is unquestionable, but the value of such data to the “wrong” people has increased considerably as well. Where the primary concern was once the productivity disruption caused by an otherwise-harmless virus outbreak, today’s malicious software is capable of finding and stealing sensitive data. The situation gets even grimmer when an active attacker such as a computer hacker attempts to gain access to steal – and sell – this data. Is this really such a big problem? Of what commercial value is student data anyway? A child’s stolen identity may not be useful for opening credit card accounts, but it can be quite valuable for defrauding entitlement programs such as Medicaid and public assistance. Not serious enough? There is also the internet trade in personal information about children used by pedophiles to locate victims. Finally, there are numerous federal, state, and local laws and regulations governing the use, transportation, and storage of sensitive data with which the NYCDOE must comply.

## ***Recommendations and Roadmap***

### **Overview**

The NYCDOE’s information security vision is achieved through four core security functions: identity and access management; vulnerability management; policy and compliance management; and awareness and education. Each of the four core security functions addresses a fundamental prerequisite for meeting the vision of ensuring that the right people have the right access to the right data. Identity and Access Management is concerned with identifying who the “right people” are, and what the “right access” is. Vulnerability Management deals with the converse of the vision – ensuring that the no one gets access that he or she is not supposed to have. Policy and Compliance Management codifies security processes into formal policies and ensures that information is accessed and stored in ways that comply with federal, state, and city mandates. Finally, Awareness and Education is dedicated to ensuring that the user community understands and respects each of the other core security functions. Each of the four core security functions is detailed below.



## Identity and Access Management

### Digital Identity

*Objective:* provide an accurate, meaningful digital identity to every NYCDOE stakeholder, whether student, teacher, administrator, parent, vendor, or partner.

Fundamental to the interaction of users with technology and information is the concept of the digital identity. The digital identity allows a computer system to understand with whom it is interacting, so that it can present the user with information personalized to his or her information needs. Digital identity is familiar to most computer users as a combination of a username and a password. However, there is much more to it than simply a set of credentials. A digital identity stores information about the user that allows for more effective interaction with computer systems.

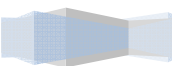
As an example, a teacher's digital identity might include the fact that she is a teacher located at school X475, teaching 9th grade English section 101. An application might, upon this user's logging on, present her with the assessment data for all the students in her 9th grade English 101 class. Similarly, a student's digital identity might reflect the fact that he is enrolled in Mrs. Harris' 4th grade math class, and when the student logs in to the school's Learning Management System website, he is automatically taken to the site for his 4th grade math class (or any others in which he is enrolled).

### Roles and Privileges

*Objective:* associate every digital identity it maintains with one or more functional roles and provide access to authorized information based on those roles.

The digital identity is great for identifying to a computer system that a user is, for example, the principal of school M125. But how does the system know that the user should see the students in M125 but not those in M126? Or, more generally, what information is this principal entitled to see? This is accomplished in two steps: first, by defining specific functional roles that individual users can hold; second, by configuring each system to provide access to information based on these functional roles. Together, these steps constitute the concept of Role-Based Access Control.

The goal of Role-Based Access Control is to create the smallest number of functional roles necessary to capture the information needs of the role members. In the NYCDOE, this may be a very large number, as any organization this large and distributed will undoubtedly have many different individual information needs. But in many cases, there is significant functional overlap between individuals. For example, the principal of school M125 has information needs that are very similar to those of the principal of M126 – the only difference between the two is the scope of information, as each need only see his or her own school's information. In this role model, both individuals are considered to have the role of "principal," though each is limited in scope to his or her own school. Many other cases are far more complex, such as individuals who hold



multiples or work at different locations, but virtually all such cases can still be achieved using this role model.

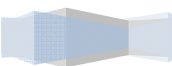
### **Automation and Workflow**

*Objective:* automate the process by which digital identities are created, managed, and deleted, devolving to business users wherever possible the ability to manage access to information.

When considering both functional roles and their associated scopes, the number of roles that needs to be managed by the NYCDOE is considerable. The principal role alone has over 1,500 members, each with a scope of a single school. Manually keeping so many roles relevant and accurate is virtually impossible. Fortunately, the NYCDOE is not the first organization faced with this challenge, and there are some very mature software systems available to automate this role management. Broadly, these software systems are referred to as Identity and Access Management systems, and deploying such a system is a core piece of the NYCDOE's security strategy.

An Identity and Access Management (IAM) system creates and maintains digital identities based on information gleaned from other computer "systems of record." For example, when an employee is entered into the NYCDOE's human resources system, the IAM system automatically creates an "employee" digital identity for that individual. Other systems provide additional information such as roles, locations, and class assignments, which the IAM aggregates and attaches to the person's digital identity. When the individual ends his or her association with the NYCDOE (e.g., an employee leaves or a student graduates), the IAM system automatically updates the digital identity to reflect this fact, ensuring that only people with a current, valid need can obtain digital identities.

Between the time that a digital identity is created and the time it is deleted (provisioned and deprovisioned, in security parlance), the identity is a living entity, constantly changing to reflect changes in the user's information needs. For example, a teacher assigned to his or her school's inquiry team needs to be given a new role and its associated privileges, and someone (e.g., a principal or data specialist) needs to authorize this new role assignment. Alternately, a principal may be going on vacation and might want to provide application access rights to an assistant principal. In either of these cases, the changes can be done manually, but managing such requests manually for the entire NYCDOE would be difficult, if not impossible. This problem is solved by another major function of IAM systems: workflow automation. Workflow automation manages the complex routing and tracking of requests to change a user's access level. With workflow automation, a data specialist in the first example above can use a simple web-based wizard to request that the teacher be assigned to the inquiry team. The workflow then automatically sends a message to the principal asking for this assignment to be approved, and upon such approval (a 1-click process), the user is immediately granted inquiry team privileges. This allows the administration of role memberships to be delegated to the people who are best equipped to do it – local managers.





## Single Sign-on

*Objective:* provide every NYCDOE user, following one sign-on, with seamless access to every system for which that user is authorized.

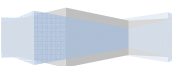
Single sign-on is basically defined as the ability of a user who logs on to a computer once to seamlessly connect to all subsequent systems without re-entering login credentials. This seemingly simple concept is generally considered the “holy grail” of Access Management, and is a goal that is notoriously difficult to realize. However, by leveraging the work being done to establish digital identities and roles, as well as another component of Identity and Access Management (IAM) software, this goal is achievable in four phases.

The first phase, generally known as “simple sign-on,” involves synchronizing a user’s credentials across all applications, so that, while a user still needs to log in to each application separately, he or she at least only needs to remember a single username and password to do so. Simple sign-on already exists across some NYCDOE systems (for example, the same username and password will log a user into Outlook email and HSST), and can be extended transparently to other systems as part of the automated user management function of an IAM system.

The second phase, generally known as “reduced sign-on,” allows a user to log on once and be able to access multiple systems without further logon. This differs from true single sign-on in that not every system is capable of using it, so while the total number of logins is reduced, more than one logon might still be required of a user. Reduced sign-on requires having an intermediate system act as a “broker,” performing system logins transparently on behalf of the user. Reduced sign-on is feasible primarily for web-based applications, and is performed using another component of IAM software.

The third phase, generally known as “enterprise single sign-on,” involves using a specialized piece of software to extend single sign-on functionality to applications not compatible with reduced sign-on technology. Using such software allows single sign-on not only for web-based applications, but also for mainframe or “green screen” applications such as ATS. This software is also a component of an IAM system.

The final phase, generally known as “web single sign-on” or “federated sign-on”, extends single sign-on beyond the boundaries of the NYCDOE. Using a technology known as Federated IAM, a NYCDOE user can use his or her NYCDOE credentials to log in to an external organization’s website. For example, a teacher wishing to log in to a third-party assessment provider’s website would be able to log in using her NYCDOE username and password, or be seamlessly logged in via single sign-on, without the NYCDOE having to replicate any user information to the assessment provider.



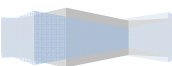
## Ubiquitous Access

*Objective:* provide every NYCDOE user with access to all information he or she requires and is entitled to see, regardless of the user's location or computing platform.

Ubiquitous access is the end result of evolving what was previously called "remote access". Once limited to highly restricted Virtual Private Networks (VPN) and dial-up-like functionality, today's technology allows anyone with a browser to have a computing experience nearly identical that the one experienced while sitting in front of a NYCDOE computer. As the technology behind ubiquitous access is covered extensively elsewhere in the DIIT strategy, this section will focus primarily on its security implications. Specifically, these include securing the network connection and securing the applications and data.

As with virtual private networking, ubiquitous access typically relies on highly insecure media, such as the internet or non-NYCDOE wireless networks, in which anyone with a laptop and basic hacking skills can electronically "eavesdrop," potentially capturing and stealing sensitive information. As a result, VPN-style connection security, in which data is encrypted or "scrambled" before being sent over the internet, is required for ubiquitous access. The difference is that instead of the highly restricted dial-up style clients used by traditional VPNs, new technology, known as SSL or Clientless VPN, allows the same security to be achieved with a simple login from any computer with a web browser.

But securing the connection is only half the battle; VPN gets a user into the NYCDOE's network, but does not necessarily provide sufficient security for sensitive applications and data. To address this gap, an additional layer of abstraction is required. This abstraction, part of an IAM system, acts as a broker on behalf of the user, fetching data from back-end systems and presenting it to the users as though they were directly connected. In the background, technology in the abstraction layer also scans the traffic to ensure that no malicious activity is taking place. The user experience resembles that of working on a NYCDOE computer, but in reality no sensitive applications are directly exposed to the internet. This intermediary also allows remote users to take advantage of single sign-on functionality, as the IAM components communicate with one another to exchange credentials on behalf of the user.



## Vulnerability Management

### Approach

If Identity and Access Management deal with opening a window wide enough so that the right individuals have the right access to the right data, Vulnerability Management acts like a mosquito net, ensuring that unauthorized individuals cannot sneak in at the same time. This is done by actively monitoring the NYCDOE's data and computing infrastructure for vulnerabilities, or "holes" in the mosquito net in order to protect the NYCDOE.

We add a quick note on terminology with regards to the difference between vulnerabilities and threats, and by extension, vulnerability management and threat management. If, in the above example, a vulnerability were a hole in the mosquito screen, a threat might be a mosquito that exploits the vulnerability (the hole in the screen) and flies in to the room to cause trouble. It may seem easier to think in terms of threat management – after all, the mosquito is what is causing the actual trouble. However, while we have no control over the mosquito, we can patch the hole in the screen. In the same way, we cannot control a computer virus or hacker, but we can patch the vulnerability that the hacker exploits to gain access to a system. Hence, the focus on managing the vulnerability, rather than the threat.

### Vulnerability Score

*Objective:* assign each school a score reflecting its level of vulnerability to compromise of sensitive data and use the score to govern access to such data.

In a traditional centralized enterprise, vulnerability management is performed by establishing restrictive standards for the configuration of computers and software and carefully monitoring and remediating any deviation from standards. This model does not work particularly well for the NYCDOE because the NYCDOE is a federated enterprise, with a central organization providing services to over 1,500 semi-autonomous operating units. While the NYCDOE has a responsibility for the security of student and employee data, it does not have centralized control over the computing environments in which that data is used. This is further complicated by the sheer number and variety of computers in schools, and the many software packages in use. As a result, the NYCDOE has to rely on individual schools to observe proper security practices while using sensitive data.

The model that most closely resembles this is the one used by credit card companies, e.g., Visa and MasterCard, to protect credit card information. In that model, Visa and MasterCard are ultimately responsible for cardholder data, but most of the processing of those cards is done by the millions of merchants that accept them as payment, merchants that Visa and MasterCard do not control. To deal with this problem, Visa and MasterCard developed the Payment Card Industry Data Security Standard (better known as PCI-DSS, or simply PCI). PCI is a list of security best practices with which merchants must comply (based on an annual audit) in order to continue to accept credit card payments. A merchant that falls short of these requirements may face restrictions in its ability to accept credit cards until such deficiencies are addressed.

The NYCDOE will use a similar model to ensure that sensitive data does not fall into the wrong hands. Each school will be assigned a Vulnerability Score based on factors including its use of virus and spyware protection, its level of malicious activity, the number of unaddressed security vulnerabilities, and the quantity, type, and use of sensitive data at the school. A school's security score will govern the level of sensitive data access and freedom to which the school is entitled. For example, a school with a high score may be able to extract student data from ATS and store it in its own systems, while a school with a lower score may lose the ability to perform such an extract and may even be prevented from storing any student data on its own computers. This model provides a deterministic framework for schools to use in meeting their responsibility for ensuring the security of student data.

### **Vulnerability Management Software**

*Objective:* provide schools with software tools for detecting and remediating gaps in their vulnerability levels.

One of the cornerstones of vulnerability management is the use of software that protects against "malware," or malicious software such as computer viruses. Installing antivirus and antispyware software on every computer is the first step towards reducing vulnerabilities. In fact, this step is so important that the NYCDOE pre-loads every computer purchased via FAMIS with two software packages designed to protect against malware. A computer from which such software was removed or a non-NYCDOE-provided computer lacking such software places a school's computing environment at risk and thus lowers the school's Vulnerability Score. However, a school in this position needs simply to request the software from DIIT and install it on the unprotected computers. This is explained in further detail under "Remediation," below.

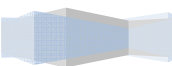
In addition to the more traditional anti-malware software, the NYCDOE is also deploying a cutting edge technology known as data leak prevention. The term data leak prevention refers to a new class of technology designed to ensure that sensitive data is stored, transported, and used only in environments where the risk of compromise is low. The NYCDOE's software can monitor these activities when sensitive data is involved, and assist schools in better managing their use of such data.

Finally, the vulnerability scanning tools used in part to develop the Vulnerability Score will be made available to schools to perform their own on-demand vulnerability scans, receiving detailed reports on the type, quantity, and location of technical vulnerabilities in their schools. Additional centralized tools usable by schools, such as those for centralized software installation, are covered elsewhere in this document.

### **Remediation**

*Objective:* provide schools with consulting services to assist them in understanding and remediating their vulnerabilities.

The goal of the Vulnerability Management program is not to stop schools from accessing the data they need; rather, it is to assist vulnerable schools in creating an environment that is sufficiently secure for such data use. As such, DIIT offers several services to assist vulnerable



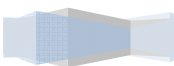
schools in remediating any deficiencies in their computing environment. These services fall into three categories: design, clean-up, and education.

Design services entail proactively assisting a school in the planning and implementation of new technologies to ensure that those technologies' use of sensitive data is done in a secure manner. Clean-up services assist a school in remediating technical vulnerabilities, and can range from the simple installation of anti-malware software to removing a massive virus or spyware infestation. Education services address situations in which a school's vulnerability is inherent not in technology itself, but rather in the way data is used by school users. Education services are also covered in greater detail in the section Awareness and Education, below. Depending on the specific circumstances, some remediation services may involve a cost to the school.

### **Incident Response**

*Objective:* respond quickly and effectively to security incidents in order to minimize the damage caused to the NYCDOE.

Sometimes, despite the best efforts taken to manage vulnerabilities, a security incident does occur. In such an event, it is critical that the NYCDOE be able to respond quickly and effectively in order to minimize the damage caused. To ensure such a response, a formal incident response framework is used. This framework includes processes for analyzing, categorizing, and prioritizing incidents, as well as specific steps to address each category of incident and a mechanism to report incidents to management. Additionally, the framework requires a post-incident analysis to determine its root cause and remediate the vulnerabilities that allowed it to occur.



## Policy and Compliance Management

### NYCDOE Policies and Standards

*Objective:* provide formalized, documented information security policies, standards, procedures, and guidelines accessible to all NYCDOE stakeholders.

The NYCDOE has formalized policies, standards, guidelines, and procedures for most of its operational areas, and information security is no exception. While these terms are often used interchangeably, each represents a specific type of artifact serving a specific purpose. Security policy is a formal statement of the NYCDOE's security objectives coupled with a high-level framework for achieving those objectives. It is focused on the "what," rather than the "how," of needs to be done to secure the NYCDOE's information. The NYCDOE's security policy is comparable to (and in many cases based on) the Chancellor's Regulations, a part of which it will eventually become. Security standards focus on the "how" of information security, providing specific requirements for implementing the security policy. Standards are comparable to the directives governing requirements for doing business issued by most NYCDOE operating divisions.

Procedures and guidelines are driven by policies and standards, but are far more targeted. Procedures are very specific, often step-by-step formalized processes used for specific tasks, such as creating a new user account or transferring data to a vendor. Information security procedures are comparable to those documented in the NYCDOE's Standard Operating Procedures Manuals (SOPMs). Guidelines are suggested practices that assist users in using technology in a more secure manner.

### External Policies and Standards

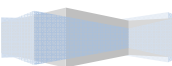
*Objective:* ensure that the NYCDOE's handling of sensitive information complies with federal, state, and city policies, regulations, and laws.

Besides its own internal policies, the NYCDOE is subject to external regulation at the city, state, and federal levels. This can range from citywide information security policies issued by the Department of Information Technology and Telecommunications (DoITT) to state-level reporting requirements to major federal privacy laws such as FERPA and HIPAA. DIIT makes every effort to integrate the requirements of these laws and regulations into its own security policies. However, it will often be necessary to refer to external bodies for guidance. DIIT also works closely with the NYCDOE's Office of Legal Services to ensure compliance with external regulations.

### Certification

*Objective:* assess the vulnerabilities of proposed technologies and systems and recommend steps for their secure deployment.

Besides creating and communicating security policies, standards, and procedures, DIIT also assist schools and other Central offices in evaluating and certifying systems and technologies as



compliant with policies. Done jointly with the Vulnerability Management function, security certification involves reviewing a proposed technology or product for security vulnerabilities and recommending ways in which the technology can be deployed in a secure manner. By taking advantage of certification services, a school or other group can ensure that a new technology will work properly in its environment without lowering its Vulnerability Score or otherwise putting it or its data at risk.

## **Awareness and Education**

### **Security Ambassadors**

*Objective:* establish a network of formal and informal Security Ambassadors tasked with communicating security information to their respective organizations.

Even if every possible technical safeguard were deployed at the NYCDOE, significant vulnerabilities can still remain if individuals do not use data responsibly. The first step towards the widespread adoption of security best practices is communication – people cannot follow practices if they do not know about them. Because the NYCDOE is so large and so distributed, it is not realistic to expect this message to be communicated effectively from a single central point. In keeping with the NYCDOE’s federated organizational structure, DIIT will establish a network of individuals within individual organizations (e.g., ISCs, SSOs, central divisions) to help push that message out to their colleagues. In recognition of these individuals’ other job responsibilities, this would be a very simple function requiring little effort – often just sending an email or making a phone call or referring a user to DIIT. Security Ambassadors would also have the full support of DIIT in addressing any security issues that arise within their organizations.

### **Security Website**

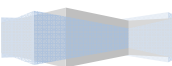
*Objective:* create a relevant, easy-to-understand, up-to-date website for communication of security information to NYCDOE stakeholders.

Much of the information about security is relevant to all NYCDOE stakeholders and can even be shared with the general public. To take advantage of this, a public-facing website will be created to communicate basic security information to broad audiences. While this may not be as comprehensive as what can be provided exclusively to NYCDOE stakeholders, it is nonetheless a quick and cheap way to expand the reach of the security awareness program. The security website will contain information such as tips for secure computing at the NYCDOE and at home, as well as links to relevant sites providing further information.

### **Security Education**

*Objective:* provide general and targeted education to NYCDOE stakeholders on secure practices and acceptable use.

Security education can take on many forms. It can be a physical class in which a group of individuals is instructed by a teacher in a formal setting. It can also be a web-based training



module available to any user with internet access. At the NYCDOE, the goal is to approach security education in the same way many other types of professional development are handled. The primary vehicle for security education will be web-based training, delivered through an online Learning Management System (LMS).

The use of a formal Learning Management System will allow users to obtain training at any time and on any topic, without the need to travel or even leave work. It will also allow the deployment of formal security curricula that can be used by schools improve a low Vulnerability Scores through user education. Finally, it can be used as a platform to launch system-specific security education, such as how to securely extract data or print reports in a particular application. More information on DIIT's general support for Learning Management Systems can be found elsewhere in this document.

### ***Benefits and Impact if Not Implemented***

The technological advances experienced in recent times and expected in the next five years open up tremendous opportunities for improving the ways in which students learn and are taught. Information is king, and whether it is being used to analyze a student's weak subjects or track a class science project, it is only of value if it can be accessed when it is needed. The proliferation of technologies enabling this access has made it easier than ever to get data to the right people, but this advance has not come without liabilities. Data that is easily accessed by the "right" people can often be accessed just as easily by the "wrong" people, with potentially disastrous consequences.

Information security is no longer about stopping annoying viruses; it is about protecting children from real harm, and must be treated as seriously as the security of the physical learning environment. The NYCDOE's information security strategy, through protections proactive and reactive, administrative and technical, and physical and virtual, ensures that our students, teachers, staff, families, and other stakeholders can safely navigate the dangers of cyberspace well into the next decade.

### ***Budget to Implement***

	3-Year Plan			Total
Components:	Year 1	Year 2	Year 3	(In mil.)
Enterprise Active Directory (AD) / Identity Management	1.14	1.14	1.14	3.42
Deployment	0.40	0.40	0.40	1.20
<b>Total</b>	<b>1.54</b>	<b>1.54</b>	<b>1.54</b>	<b>4.62</b>

Assumption:	Estimated Timeline
Provide EAD to all schools	3-5 Years



## SECTION 9: STUDENT/TEACHER LEARNING AND COLLABORATION

### *Vision*

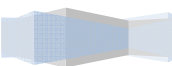
In order to deliver the new 21<sup>st</sup> century classroom experience, we see an environment where the classroom for our students is extended beyond the school. Our students want to create a presentation about preserving resources and creating a green planet. They conduct a live interactive video lecture with a researcher at NASA who presents them with a slide show live on line, and the students ask interactive questions during the presentation in real time. Once the presentation is complete the students launch their Virtual Desktop in the class and start working on their presentation. During the presentation the teacher can assist the students by projecting their work on an interactive smart board and discuss issues with them while everyone is also doing research on the Internet. Once the students go home and want to complete their assignments, they use their home and or library PC to launch the school portal via a web browser or create a secure remote session (VPN) to the DOE, and launch their desktop if they need to use specific tools. Since the school portal gives them their unique homepage, the look and feel of this is exactly the same no matter where they log in from, and their assignments and homework are stored in their ePortfolio system which grows with them and can be transferred when they graduate or move to another school or district.

The Educators employ an online Learning Management System (LMS) to impart differentiated anywhere/anytime learning for their students. The Enterprise Learning Portal (ELP) is used to create new curriculum and share with staff across the DOE environment to create a new era of learning.

### *Goal and Strategy to Obtain Vision*

*School Technology Goals:* Enhance the technology to support the teaching and learning experience for all students and educators.

- ⊕ Enhance the learning experience for collaboration teaching and learning.
- ⊕ Equip and train our students with the skills required in today's economies.
- ⊕ Create a replicable curriculum and spread the learning experience across the DOE schools.



## School Technology Strategies

- ⊕ Implement an enterprise-wide scalable Learning Management system
- ⊕ Create an Identity store to manage student and parents identities
- ⊕ Implement and deploy collaborative technologies to support IP Video Conferencing, Centralized storage, and VPN Remote access.
- ⊕ Enhance Primary WAN circuit bandwidth and provide redundancy for the WAN circuit for any time any where access around the clock.
- ⊕ Deploy secure remote access solution for allowing trusted users to access their resources while mitigating attacks.
- ⊕ Provide centralized Unified Communication Platform for voice and video conferencing.
- ⊕ Provide support for Professional Deployment and increase the efficiency of the technology support.
- ⊕ Implement enabling technologies to support rich media content.
- ⊕ Use cloud infrastructure to provide “on-demand” elasticity, scalability and performance.

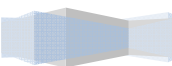
## Current State

Currently, we have the VoIP cluster to service the schools that have VoIP deployed. In addition to that we currently have a Video Conferencing Gateway that is not integrated. The Video conferencing units cannot support the High Definition Video that enables the students to get an immersion experience. There are schools that will not be able to take advantage of the technologies, as they are still on T1 circuits and layout cost for EVPL is too high. All schools rely on a single circuit to provide connectivity to resources and as we provide more applications and storage a redundant WAN connection would be vital to maintain the learning experience.

We have Silos of storage, but no centralized storage built out for students that can grow with their needs and store their school achievements. We have no way to retain a history to be used later, as our students become tomorrows’ leaders.

Most of the workstations in our schools are unmanaged and tend to be lagging behind in security posture and patches; this, in turn, makes them vulnerable to become hosts for viruses and relay hosts for bots.

We need to build an Enterprise Learning Portal that builds on the proven success of individual schools that have been early adopters of such innovative techniques to impart learning. The ELP will contain invaluable material capturing the experience from our teaching community and we would like to have all educators’ access to the growing portal and allow them to contribute to the contents and students curriculum.



## ***Future State***

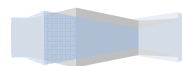
Provide redundant circuits to all schools where logistically possible and have WAN link failover capability; this will ensure continued learning experience if one of the ISCs encounters a power or network outage. This redundant connection, along with providing EVPL circuits to all schools, will truly provide the missing components to the shared experience of Virtual Desktop, Shared Storage, LCMS and Unified communication (Voice and Video) experience.

## ***Recommendations and Roadmap***

Build a centralized environment where our Storage Area Network is shared by all schools, and is accessible by students and educators throughout the DOE system. In order to create and work, the students will launch a Virtual desktop that is accessible from anywhere at any time. We currently lack redundant links to the schools using an MPLS or DMVPN technology. Redundant connections will help us ensure access and connectivity to the system wide resources. As these resources become centrally located we will ensure that access is guaranteed. This will also allow the NYCDOE to move away from maintaining distributed computing power and maintain a proper handle on the software licensing and deployment of DIIT resources. Providing access to the latest collaboration and work environment will assure our students of being trained in today's relevant technologies as they prepare for higher education and a leap towards leadership roles.

CREATION OF VIRTUAL LEARNING ENVIRONMENTS: Research indicates that immersive virtual environments are powerful tools of experiential learning that increase student achievement. Medical schools, the aerospace industry, and the military are just some of the institutions that have significantly invested in virtual environments to provide a style of learning that meets the needs of today's student. In the K-12 realm, software publishers and schools districts are racing to incorporate immersive learning into the curriculum. Our students will be provided with proven instruments of virtual learning that engage, motivate, and excite students, moving them towards success in mastering all content areas.

DEVELOPMENT OF A PROFESSIONAL DEVELOPMENT LEARNING CONTENT MANAGEMENT SYSTEM (Adult LCMS): There is a great disparity in the professional development needs and modes of delivery among individual schools within the DOE. Schools are not only challenged with finding professional development services that can be applied to their specific instructional settings, but are also challenged with time and location constraints. The Office of eLearning Services will work collaboratively with the Talent Office to identify an LCMS partner. Together, they will develop online courses that allow educators and other participants to learn at their own pace, in a variety of modes best suited to personal learning styles, at a remote location, at any time. In addition, the amalgamation of current core curriculum teaching strategies within simulated learning environments will allow participants to acquire real knowledge in a real-world context that is often difficult to replicate with limited 20th century tools. Lastly, eLearning's professional development offerings will take into consideration the ways in which school inquiry teams address specific needs or challenges in their respective school through the



analysis of many data and assessment types. Our training modules will depict what schools are currently doing to improve student achievement, and respond to their unique instructional circumstances.

**DEVELOPMENT OF ONLINE CORE CURRICULAR SUPPORTS:** The Office of eLearning will instruct participants on how to integrate twenty-first century technology innovations into teaching and learning through online learning communities, project based learning and virtual environments that support student success.

***We will:***

1. Provide support and resources for online learning communities to collaborate around integrating technology into curricula and instruction.
2. Develop resources to support the integration of instructional technology into the citywide implementation of the core curriculum.
3. Partner with several innovative technology-base curriculum projects in the core content areas.

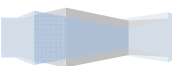
## **Division of Instruction and Information Technology/Division of Accountability and Achievement Resources (DIIT/DAAR)-NYC21C Model Schools**

The NYC21C initiative is intended to transform teaching and learning practices by providing students in model schools with 21st century skills that will prepare them for higher education and careers in the global economy. Students will use 21st century tools to solve problems/engage in project-based learning with real world applications.

NYC21C schools will utilize an Enterprise Learning Portal (ELP) to deliver instruction to students. Through this implementation, teachers will design and post online courses in the core content areas that are in alignment with the NYS standards, develop assessment tools to identify and monitor students' progress, and build capacity by establishing an online community where resources can be shared. School leaders will use the ELP as a portal for the school community to post announcements, communicate with parents, and develop a collaborative learning environment. .

***Participants will:***

1. Experience learning in an online environment
2. Design an online course in the content areas to be used with students
3. Differentiate instruction by modifying courses to meet the needs of individual learners
4. Establish and support an online learning community that will serve as a forum to collaborate, post best practices and share resources.



DIIT/DAAR will sustain the ELP by providing training to NYC21C teachers and school leaders in developing online courses and materials to support teaching and learning and student achievement.

***We will:***

1. Provide an asynchronous, moderated course in Moodle for NYC21C school leaders and teachers in online learning and course development
2. Work closely with NYC21C school leaders to provide consultation and professional development to support the LCMS and help transform the teaching and learning environment.

NYC21C schools will employ an onsite technology coordinator who will serve as a resource and provide support and instructional technology professional development to classroom teachers in sustaining the LCMS.

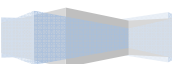
***Benefits and Impact***

Supporting Innovation and broadening the boundary of the learning environment by providing access beyond the limits of the school schedule. Enable students to interact and provide a global classroom.

***Budget to Implement***

<b>Components:</b>	<b>3-Year Plan</b>			<b>Total</b>
	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>(In mil.)</b>
Learning Management System	1.40	1.40	1.40	4.20
Deployment	1.00	1.00	1.00	3.00
<b>Total</b>	<b>2.40</b>	<b>2.40</b>	<b>2.40</b>	<b>7.20</b>

<b>Assumptions:</b>	<b>Estimate Timeline</b>
Deploy Learning Management System solutions to 500 schools	3-5 Years



## SECTION 10: USER SUPPORT (NOC AND SERVICE CENTER)

### The Network Operations Center (NOC)

#### *Vision*

The future vision for the NYCDOE NOC is for its expansion from a centralized and proactive network management facility supporting DIIT staff at 2 MetroTech Center to a distributed information system that will provide individual schools a view into their own buildings' infrastructure, empowering principals and administrators to make informed strategic and instructional decisions regarding their school's network.

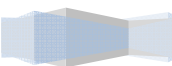
This vision of the DOE NOC supports the effort to transform the DOE Support Community, including IT Support Staff, IT Management, School Administrators and Educators, making it more connected, more agile and better organized to share information and coordinate actions.

The NOC will strive to empower the Support Community with seamless and ubiquitous access to IT resources that make the state of the computer network clear and visible. Using these resources, DOE support organizations can manage, anticipate and mitigate problems, ensuring uninterrupted availability and provide for graceful degradation, self-healing, failover, diversity, and elimination of critical failure points.

#### *Goal and Strategy to Obtain Vision*

In order to achieve this vision, we need to expand the current NOC services through infrastructure build-out and support. Through a series of physical and system enhancements, the NOC will become an even more valuable state-of-the-art facility. The expansion will focus on the following goals:

- ⊕ Expand the physical structure of the NOC so it will be able to house additional engineers
- ⊕ Expand NOC physical space
- ⊕ Add additional seating & monitors
- ⊕ Increase number of Level II & III personal
- ⊕ Implement changes that will reduce service downtime and improve time-to-recovery
- ⊕ Allow for school administrators to have a view into their own network infrastructure
- ⊕ Provide access to trend data for capacity management and planning at the school level
- ⊕ Provide a methodology for monitoring wireless computing at the ISC and the school level.



## Current State

By centralizing technical resources, and implementing network management systems, the NYCDOE NOC is currently positioned to:

- ⊕ Provide a common view of network systems across the enterprise
- ⊕ Provide proactive end-to-end network and systems management to maximize the availability of applications and services to users
- ⊕ Coordinate management activities from a single Network Operations Center
- ⊕ Upgrade to industry-standard network management and notification systems, such as HP OpenView, NetCool, MRTG, and Netflow.
- ⊕ Integrate these systems into a cohesive streamlined set of management tools

The use of certain Network tools, such as HP OpenView and NetCool is integral to the success of the NYCDOE NOC. As the diagram below illustrates, the output from all the independent network monitoring systems and HP OpenView, now reports in to one common notification system, which is NetCool.

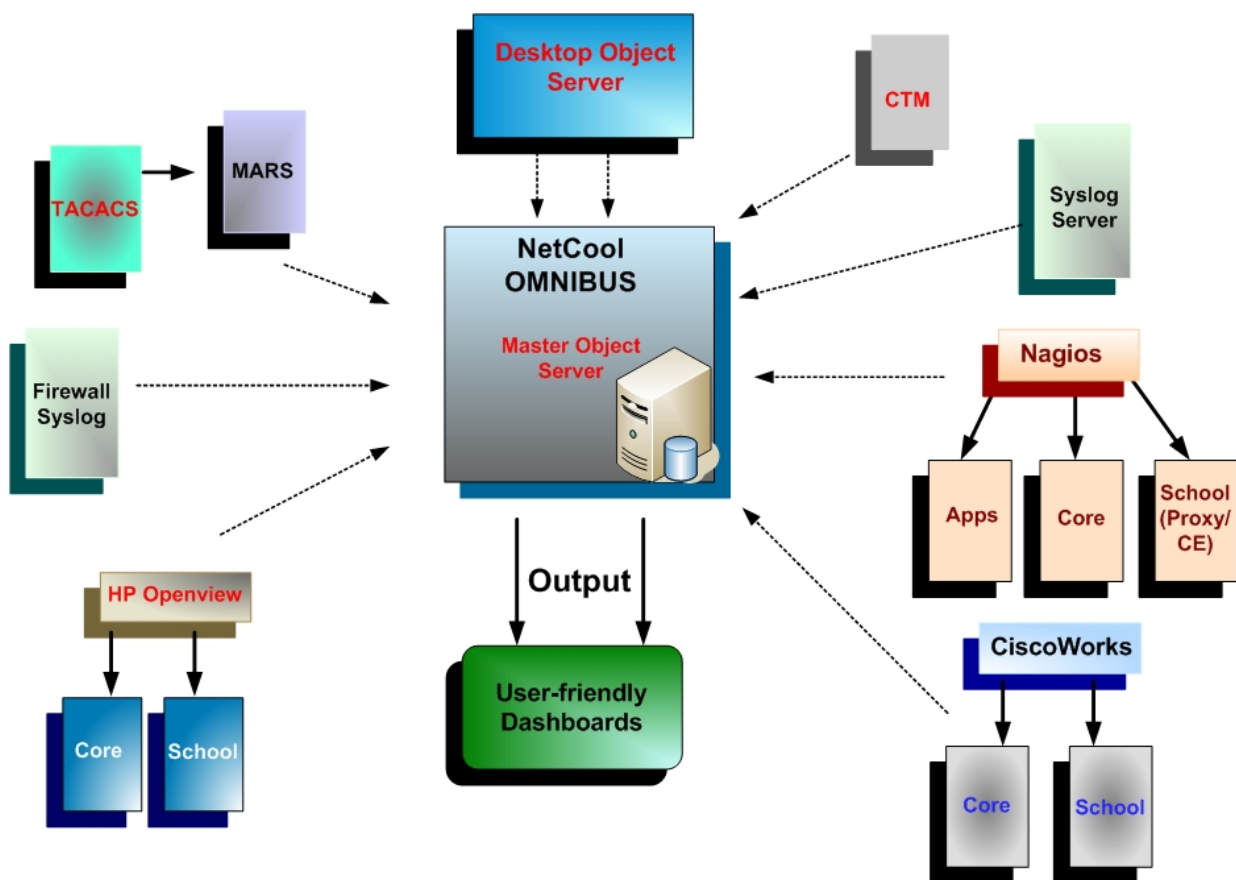


Figure 10-1: NOC Overview

In addition to providing real-time alerts to network failures, NetCool supports the concept known as Event Correlation. For example, if a fiber is cut, many network devices will immediately generate alarms, indicating loss of signal. The NOC Engineer analyzes each individual alarm, and eventually determines that the cut fiber is the root cause for the alarms. Netcool provides a dynamic shortcut to this type of scenario. NetCool correlates all the events/alarms, and generates one alarm that indicates to the NOC Engineer the root cause of the network failure.

These network management systems also store various types of historical data which currently enables the NOC to proactively:

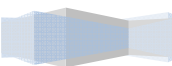
- ⊕ Monitor performance
- ⊕ Analyze trends
- ⊕ Set thresholds
- ⊕ Predict problems
- ⊕ Automate systems management

### ***Target State (Future State)***

The NOC will adjust its operational framework to add two essential tasks, Operational and Situational Awareness, and Command & Control.

Operational and Situational Awareness' primary purpose is to improve the quality and timeliness of collaborative decision-making. This shared situational awareness should be derived from common reporting requirements using functionally standardized enterprise-wide management tools and common data information exchange formats. These tools should collect, and fuse (network management, network defense and configuration management) data in a real time fashion to produce defined views that enable the Support Community to maximize support of IT infrastructure.

Command & Control's primary purpose is to improve response time for problem resolution at the school, with an average mean time to resolve issues being that of no more than two days. In addition, the NOC would support "War Room" situations in response to serious problems in the network. These activities will be coordinated in the NOC and would require the presence of Level II & Level III engineers.





## Recommendations and Roadmap

- ⊕ Improve the current processes to address new needs and collaborate more efficiently with other IT Groups.
- ⊕ Place greater emphasis on ensuring acceptable network and application performance.
- ⊕ Increase their skill sets of NOC personnel as the “next generation” NOC begins to address additional IT areas and new Technology.
- ⊕ Integrate and standardize Network Management tools.
- ⊕ Ensure that NOC staff acquires more application literacy and collaborates more effectively with network engineers, enterprise architects and IT managers to improve application delivery.
- ⊕ Combine network and security operations in the NOC in response to the growing emphasis on DOE security.
- ⊕ Accelerate the transition from reactive to proactive NOC operations. In spite of the widespread interest in being proactive, most NOCs, including the NOC at DIIT, primarily operate in a reactive mode, identifying a problem only after it impacts end users. The migration away from today’s reactive NOC will require the active involvement of both senior management as well as rank and file members of the operations groups.

## Benefits and Impact if Not Implemented

- ⊕ By providing real-time infrastructure service availability information to administrators and instructors at schools, the NOC will enable NYCDOE educators to plan their workday more effectively. For example, by knowing that internet service will not be available today between 10 AM – 12 PM, educators can work on alternate plan for his/her class.
- ⊕ This effort also has a cost-saving benefit. By making network information available locally.
  - Users will save time on troubleshooting because he/she is already aware of the issue.
  - The DOE can reduce the need for expensive helpdesk services.

## Budget to Implement

	3-Year Plan			Total
	Year 1	Year 2	Year 3	(In mil.)
Components:				
Infrastructure Build-out for support	2.50	2.50		5.00
Redundant Hardware and Software Systems		1.75	1.75	3.50
System Enhancements (Tools and hardware)			1.25	1.25
<b>Total</b>	<b>2.50</b>	<b>4.25</b>	<b>3.00</b>	<b>9.75</b>

## Help Desk (Service Center)

### *Vision*

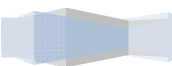
The long-term vision for the DIIT Service Center is its transformation from being a reactive support organization, to a proactive support organization that is built on sound business practices among the Customer, the Service Center, and the Level II/III support groups. The Service Center will need to be flexible in its ability to adapt to the ongoing changes in technology, and the new support requirements that will evolve.

### *Current State*

Today, the Service Center is a reactive support organization that responds to user calls and inquiries as they occur. Trending of user data as a means of helping to assess weaknesses/deficiencies, identify problematic equipment, or identify gaps in processes, is almost non-existent. The current Customer Relationship Management application is limited in terms of functionality and flexibility, and is being challenged by our current growth rate. A separate Web interface had to be built and maintained to provide users with the ability to submit tickets online; this feature is standard on most products in today's market. There is no type of knowledge base in place to serve as a resource for agents or users as a quick means of resolving issues. As a result of this, NYCDOE application and Infrastructure support rely largely on the institutional knowledge of each individual agent. Any time an agent leaves (which is common in the Service Center environment), there are lead times of 4 to 8 weeks before new staff becomes productive. Also, excessive amounts of time are spent researching repeat issues/calls due to the lack of a k-base application, which all translates into delays or poor service to the end users. There are no remote capabilities that exist at the Service Desk that allow an agent to take control of a user's workstation to resolve a problem. This, then, requires the agent to have to work with a user who may be somewhat challenged by what the agent is asking him to do. This all leads to users being frustrated, which is a poor reflection on the Service Desk.

### *Trends in Subject Area*

The trend for Service Centers is to provide customers with enhanced Web self-service functionality. This can be accomplished in a number of different ways: from the very basic (of providing a means for user to submit incidents via the Web without having to place a call, or providing users with a means of tracking status of their tickets), to the more sophisticated (of providing users with ability to search a database for a solution to their issue and eliminating the need to have to open an incident at all, or providing users with access to video clips that take them through step-by-step instructions on how to resolve their issues).



## ***Recommendations and Roadmap***

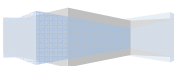
Just as technology continues to evolve, and move in the direction of being more mobile, the Service Center needs to be structured in such a way that allows it to evolve and adapt to new and changing demands for support. A key factor in making this a reality is to ensure that the Service Desk has the proper tools in place to allow for this growth, and so provide the customers with the high level of support they need.

### **Recommendations:**

- ⊕ Provide schools with an enhanced Web Self-Service, where they can query a database, for possible solutions to their issues, without the need to place a call. Provide video clips of step-by-step instructions for common how-to's that clients can use as a tool.
- ⊕ Replace the existing Customer Relationship Management ticketing application with a more robust application, to allow greater functionality at the user and client level. This may be part of the call center consolidation project, but there is a true need here that needs to be addressed before we bottom out.
- ⊕ Develop Performance Management reports portfolios for customers and management, showing data trends in terms of incidents reported, requests made, Internet and bandwidth activity etc., to allow for the better allocation and focus of resources.
- ⊕ Implement a shared Dynamic Knowledge Base application to facilitate the sharing of information across multiple and varied platforms, to assist with, and improve upon, the timeliness of resolutions to issues.
- ⊕ Develop a DIIT Service Catalog that clearly defines service offerings. One-stop shopping may be provided through an IT Portal for customers requesting DIIT services.
- ⊕ Provide Service Desk with remote access capabilities to enhance Level I resolutions.
- ⊕ Continue to engage the Client community to get input on what services are important to it.
- ⊕ Procure an Asset Management Tracking tool to increase quality and accuracy of asset database.

## ***Stakeholder Use Case***

All DOE staff who have ever had a need to contact the DIIT Service Center for hardware, software or network related issues. Today, we receive 30,000 to 40,000 calls a month, with a growth rate of over 10% a year. Unless we put better mechanisms in place, this number will only continue to rise.

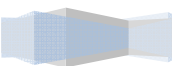


## ***Benefits and Impact***

Given that the NYCDOE is a very unique environment that doesn't follow your typical business support model (one where customers sit at a desk and are readily available for tech support to troubleshoot and assist), there is very little opportunity to capture information and resolve issues; therefore, having the appropriate tool sets in place is critical to providing outstanding customer service.

## ***Budget to Implement***

	3-Year Plan			Total
Components:	Year 1	Year 2	Year 3	(In mil.)
Replacement of existing Customer Relationship Management Applications	1.00	1.00	1.00	3.00
• Hardware				-
• Software				-
• Consultant Services/Training				-
Service Management Build-out	1.00	1.00	1.00	3.00
• Self Enablement Portal				-
• Request for Service build- out				-
• Knowledge Base				-
• Asset Management tool				-
<b>Total</b>	<b>2.00</b>	<b>2.00</b>	<b>2.00</b>	<b>6.00</b>



## SECTION 11: EVALUATION AND ASSESSING NEW TECHNOLOGY

### *Vision*

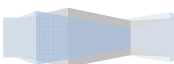
DIIT typically works with several vendors before introducing any new technology. The process may include multiple iterations, starting with a test in DIIT's proof of concept lab, followed by a piloting of new products in schools and testing performance against a specified check-list of tasks. DIIT engineers would identify the most important product features, assign "weights" to them to quantify their relative importance, and complete a matrix such as the one shown in Figure 12.1, below. (FR refers to a functional requirement; NFR refers to a non-functional or operational requirement.)

Selection Matrix

Requirements	FR1	FR2	FR3	NFR1	NFR2	NFR3	NFR4	Total Weight 0
Weight								0
Ranking: (0 - 10) "0" if product feature is not available, "1" with poor quality feature(s), and 10 for best of class.								Comment
Vendor A								
Rank	6	7	8	7	7	6	8	Final Score 0
Weighted Score	0	0	0	0	0	0	0	0
Ranking: (0 - 10) "0" if product feature is not available, "1" with poor quality feature(s), and 10 for best of class.								Comment
Vendor B								
Rank	7	5	8	6	7	6	2	Final Score 0
Weighted Score	0	0	0	0	0	0	0	0

Figure 11-1: Selection Matrix

The evaluation process that takes place prior to technology deployment is both rigorous and well-defined. The same cannot be said for technology evaluation once the technology is deployed in the field.



DIIT's vision for evaluating new technology includes a new process that allows DIIT to monitor the progress that educators at schools and libraries are making with technology after it is introduced, allowing DIIT to evaluate the utility of new technology and understand how it impacts student achievement.

### ***Goal and Strategy to Obtain Vision***

DIIT's goal is to incorporate user evaluation as an integral component of every new technology roll-out. A requirement to include user evaluation would be part of each new RFP (Request for Proposal). The methodology for evaluation would vary from product to product, and be developed jointly by vendor and NYCDOE staff.

### ***Current State***

Currently, our understanding of how effective technology is after it is deployed is largely anecdotal. DIIT staff often works with users, answering questions about technology, and in the course of this interaction gets a better understanding of how the technology is used at schools. But there is no formal process to evaluate technology and address problems. Some technologies are rarely used after they have been deployed. An evaluative process as the technology is rolled out, might allow the NYCDOE to address aspects of the technology that later prove to be problematic.

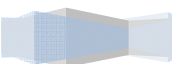
### ***Target State***

The target state is an environment in which every technology is periodically evaluated by users, and these evaluations are used to accelerate, improve or curtail the deployment of the technology in the schools. It is in the DOE's best interest to ensure that technology that users' value, and that improves student performance, is widely deployed.

### ***Recommendations and Roadmap***

Such a process starts with meetings between vendor staff, engineering staff at DIIT and members of the user community, to identify the desired goals. Understanding what users hope to gain from the new technology is a necessary step for deciding if the technology introduction is successful. Once the criteria for success are understood, engineers and users should agree on a methodology for evaluation. This will vary by technology. In some cases, the methodology may require the use of an evaluation form or questionnaire that will be completed periodically by school staff using the technology. In others cases, it may require nothing more than monitoring the network to quantify variables such as bandwidth utilization.

The periodic review of these results by DIIT staff, along with follow-up meetings between users and engineers, can allow technology deployment to follow a number of different paths, each of which is valuable. One might be to accelerate deployment of technology that quickly proves to be very valuable, making the technology available to a larger base of users. A second is to work



with the vendor to incorporate new features that users realize would enhance the utility of the technology. Another is to identify problems or limitations of the technology that went undiscovered during the initial testing. The technology environment found in NYCDOE schools is so diverse, that technology that often works well in one school will perform poorly in another. Sometimes, only experience with the technology in diverse school settings can reveal what these problems are. Finally, one possible outcome is to realize that the technology is not accomplishing what it was intended to do, and that plans for deployment should be curtailed. This will be crucial information for the DOE.

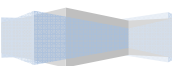
This Quality Assurance process, completed at regular intervals after technology deployment, should be an integral component of all DOE's technology plans. Only by being open to all possible outcomes, will new technology be deployed in an optimal way at the DOE.

### ***Benefits and Impact if Not Implemented***

Incorporating user evaluations in the technology deployment process will ensure that the NYCDOE is deploying technology and applications that best meet user needs. It allows the NYCDOE to expand the role of the most useful technologies, and curtail the deployment of technologies and applications that are not embraced by the user community. Only by canvassing users to understand how they use technology can the NYCDOE be sure that its investment in technology is well-spent. If this is not done, the NYCDOE risks investing in technologies that are inefficient and not widely used.

### ***Budget to Implement***

The budget for user technology evaluations will be incorporated into vendor pricing as part of the RFP process.



## SECTION 12: OVERALL BUDGET PLAN

The matrix below summarizes the budget estimates provided in the technology sections in this Strategic Plan.

### *Budget to Implement*

	3-Year Plan			Total
Section:	Year 1	Year 2	Year 3	(In mil.)
Section 4: Upgrading school infrastructure models for 300 schools	15.60	15.60	15.60	46.80
Section 5: Data Center Services/Unified Storage	78.00	42.00	30.00	150.00
Section 6: Deploy Unified Communications/Collaboration solutions to 300 schools	16.00	6.00	6.25	28.25
Section 6: Deploy Next Generation Wireless	8.00	8.00	8.00	24.00
Section 7: Deploy user devices to 600 schools	76.00	69.00	69.00	214.00
Section 8: Information Security and Identity	1.54	1.54	1.54	4.62
Section 9: Learning Management Systems	2.40	2.40	2.40	7.20
Section 10: Enhancements to Network Operations Center (NOC)	4.50	6.25	5.00	15.75
<b>Total</b>	<b>202.04</b>	<b>150.79</b>	<b>137.79</b>	<b>490.62</b>

These are summary results; detailed breakdowns of these figures appear in the individual sections.

The numbers provided here need to be viewed as guidelines/high level estimates rather than as precise budgets. There are two reasons for this:

- ⊕ First, technology changes rapidly. Over the course of the five year horizon of this Strategic Technology Plan, new technologies will emerge that will be incorporated into DIIT's plans. Their inclusion will change the budget requirements.
- ⊕ Second, the technologies described in this plan are at various stages of maturity, and the accuracy of the budget estimates reflects that. Some, like the technology plans proposed for security and wireless, reflect ongoing efforts that have already begun. Plans may change as new and better technologies appear, but the estimates provided for proposed changes are fairly accurate. Others, like the plans to incorporate cloud computing and centralized storage for student activities, are just being started at the DOE, and our estimates will change over time.